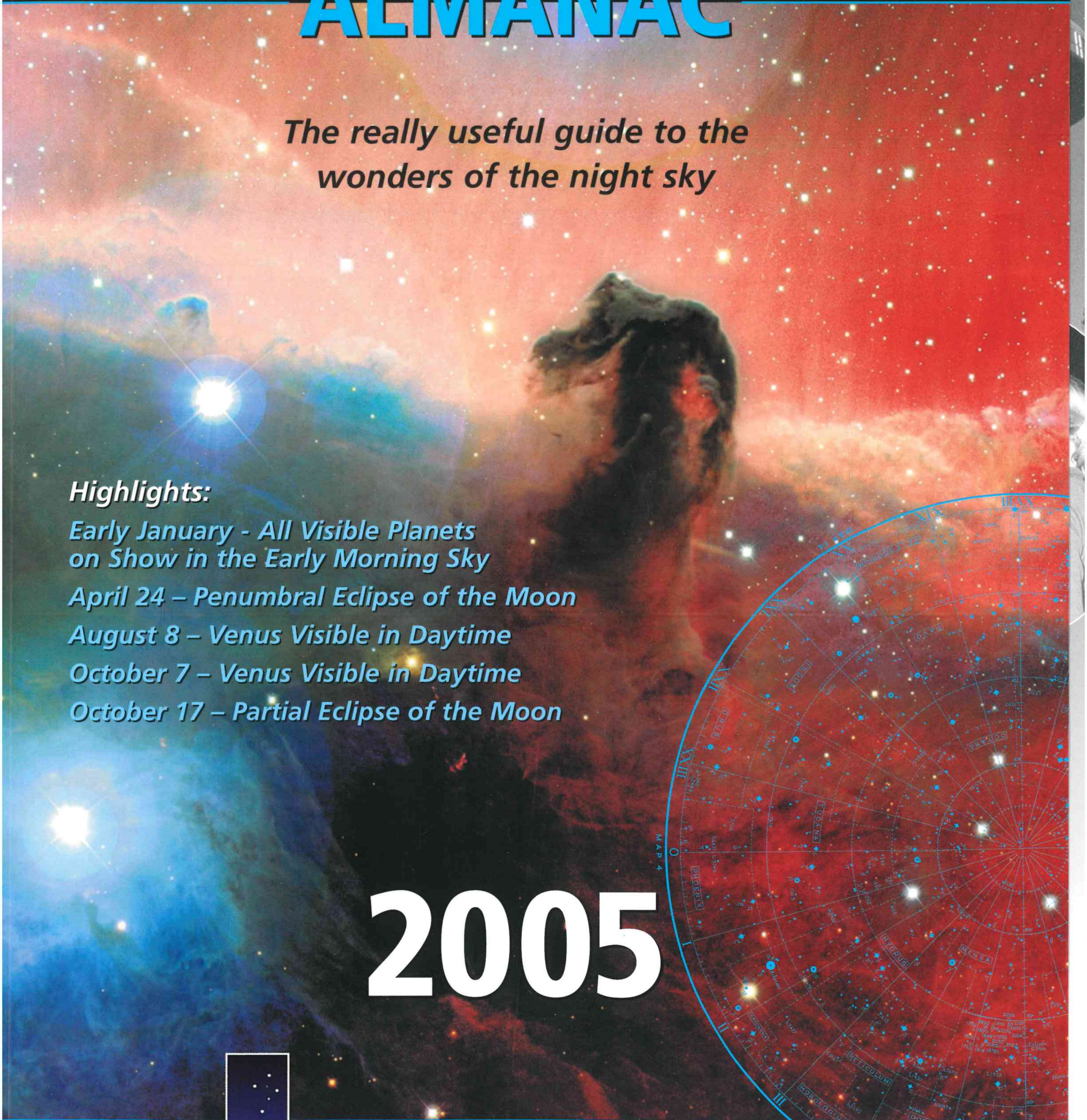
WESTERN AUSTRALIAN

ASTRONOMY ALMANAC



The really useful guide to the wonders of the night sky

Highlights:

- *Early January - All Visible Planets on Show in the Early Morning Sky*
- *April 24 – Penumbral Eclipse of the Moon*
- *August 8 – Venus Visible in Daytime*
- *October 7 – Venus Visible in Daytime*
- *October 17 – Partial Eclipse of the Moon*

2005

GOVERNMENT OF WESTERN AUSTRALIA

DEPARTMENT OF
Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

PERTH OBSERVATORY

2005

JANUARY 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
30	31					1
2	3	4 ◐	5	6	7	8
9	10 ●	11	12	13	14	15
16	17 ◑	18	19	20	21	22
23	24	25 ○	26	27	28	29

FEBRUARY 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2 ◐	3	4	5
6	7	8	9 ●	10	11	12
13	14	15	16 ◑	17	18	19
20	21	22	23	24 ○	25	26
27	28					

MARCH 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2	3	4 ◐	5
6	7	8	9	10 ●	11	12
13	14	15	16	17	18 ◑	19
20	21	22	23	24	25	26 ○
27	28	29	30	31		

APRIL 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2 ◐
3	4	5	6	7	8	9 ●
10	11	12	13	14	15	16 ◑
17	18	19	20	21	22	23
24 ○	25	26	27	28	29	30

MAY 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1 ◐	2	3	4	5	6	7
8 ●	9	10	11	12	13	14
15	16 ◑	17	18	19	20	21
22	23	24 ○	25	26	27	28
29	30 ◐	31				

JUNE 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1	2	3	4
5	6	7 ●	8	9	10	11
12	13	14	15 ◑	16	17	18
19	20	21	22 ○	23	24	25
26	27	28	29 ◐	30		

JULY 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
31					1	2
3	4	5	6 ●	7	8	9
10	11	12	13	14 ◑	15	16
17	18	19	20	21 ○	22	23
24	25	26	27	28 ◐	29	30

AUGUST 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1	2	3	4	5 ●	6
7	8	9	10	11	12	13 ◑
14	15	16	17	18	19	20 ○
21	22	23	24	25	26 ◐	27
28	29	30	31			

SEPTEMBER 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1	2	3
4 ●	5	6	7	8	9	10
11 ◑	12	13	14	15	16	17
18 ○	19	20	21	22	23	24
25 ◐	26	27	28	29	30	

OCTOBER 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
30	31					1
2	3 ●	4	5	6	7	8
9	10	11 ◑	12	13	14	15
16	17 ○	18	19	20	21	22
23	24	25 ◐	26	27	28	29

NOVEMBER 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
		1	2 ●	3	4	5
6	7	8	9 ◑	10	11	12
13	14	15	16 ○	17	18	19
20	21	22	23	24 ◐	25	26
27	28	29	30			

DECEMBER 2005

Sun	Mon	Tue	Wed	Thu	Fri	Sat
				1 ●	2	3
4	5	6	7	8 ◑	9	10
11	12	13	14	15	16 ○	17
18	19	20	21	22	23	24 ◐
25	26	27	28	29	30	31 ●

● New Moon ◑ First Quarter ○ Full Moon ◐ Last Quarter

W E S T E R N   A U S T R A L I A N

ASTRONOMY ALMANAC

2005

CONTENTS

ISBN 0-9581963-2-X

Published in October 2004 by:
Perth Observatory, 337 Walnut Rd, Bickley 6076, Western Australia
Phone: (08) 9293 8255 Fax: (08) 9293 8138 Website: www.wa.gov.au/perthobs Email: perthobs@calm.wa.gov.au

Western Australian Astronomy Almanac 2005 may be purchased directly from Perth Observatory,
Phone (08) 9293 8255, or from all good booksellers.

Disclaimer: Perth Observatory has gone to a great deal of effort to ensure that all the details in this almanac are correct. However, the Perth Observatory cannot be held responsible for any eventuality arising out of the use of the data herein. It is advisable to contact Perth Observatory directly with your astronomical data requirements in order to maximise their quality. Please note that charges apply for such consultancies.

ACKNOWLEDGEMENTS

Thanks to Perth Observatory staff for proof reading and input, Peter Pieloor of Ali B Design for all the graphic design work, and the taxpayers of Western Australia who have supported Perth Observatory for over a century.

Information for this almanac was adapted from the following sources:

'Astronomical Almanac for the Year 2005', (US Naval Observatory/H.M. Nautical Almanac Office, Rutherford Appleton Laboratory).

'Astronomical Tables of the Sun, Moon and Planets', 2nd ed., 1995, by Jean Meeus, Willmann-Bell Inc.

'The Cambridge Guide to the Constellations', 1995, by Michael E Bakich, Cambridge University Press.

'Eclipse! The What, Where, When, Why and How Guide to Watching Solar and Lunar Eclipses', 1997, by Philip Harrington, John Wiley & Sons, Inc.

'Explanatory Supplement to the Astronomical Almanac', 1992, ed. by P. K. Seidelmann, University Science Books, Mill Valley, California, USA.

'Mathematical Astronomy Morsels', 1997, by Jean Meeus, Willmann-Bell Inc.

'More Mathematical Astronomy Morsels', 2002, by Jean Meeus, Willmann-Bell Inc.

'The Southern Sky Guide', 1993, by David Ellyard & Wil Tirion, Cambridge University Press.

'Total Eclipses: Science, Observations, Myths and Legends', 1999, by Pierre Guillermier and Serge Koutchmy, Springer – Praxis Series in Astronomy.

'Astronomy and Astrophysics in the New Millennium', National Research Council USA, National Academy Press.

Heavens Above website http://www.heavens-above.com

ICQ/CBAT/MPC World Wide Web pages http://cfa-www.harvard.edu/iau/

International Meteor Organization http://www.imo.net/

JPL Solar Systems Dynamics Group http://ssd.jpl.nasa.gov/

SIMBAD database, operated at CDS, Strasbourg, France http://simbad.u-strasbg.fr/sim-fid.pl

Sky and Telescope magazine http://skyandtelescope.com/

United States Naval Observatory http://www.usno.navy.mil

US Geological Survey Planetary Nomenclature http://planetarynames.wr.usgs.gov/

ICE version 0.51, US Naval Observatory, Nautical Almanac Office

Starry Night Pro, version 3.0.2, Sienna Software Inc.

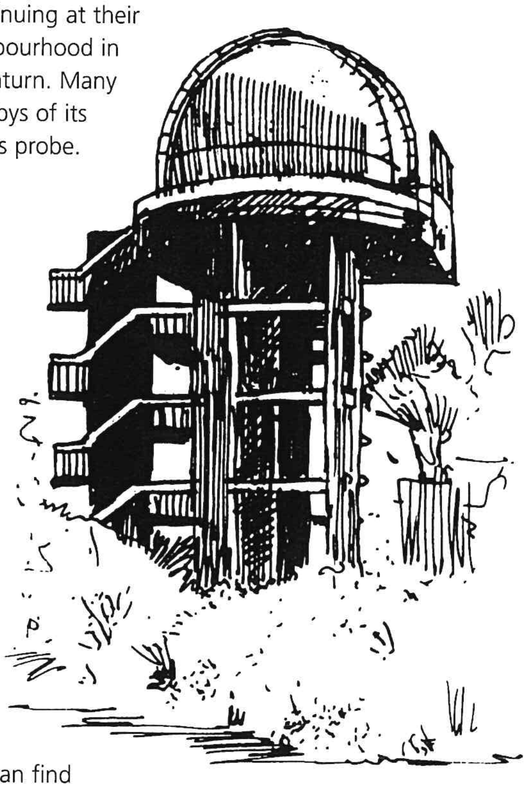
***Front cover image**: The Horsehead Nebula in Orion, is part of a large, dark, molecular cloud known as Barnard 33. The red glow originates from hydrogen gas predominantly behind the nebula, ionized by the nearby bright star Sigma Orionis. The dark patches are obscurations caused by thick dust. Bright spots are young stars just in the process of forming. Light takes about 1500 years to reach us from the Horsehead Nebula. Unfortunately, this object is rather faint and a large telescope is required in order to even image this nebula. © Canada-France-Hawaii Telescope / J.-C. Cuillandre / Coelum.*

INTRODUCTION

Astronomy is one of those enduring fields of endeavour that captures the imagination and inspires us all. This year will probably be like so many others with astronomical discoveries continuing at their apparently relentless rate. Many of these discoveries will originate in our local neighbourhood in the Universe from the Cassini spacecraft as it orbits the magnificent ringed planet Saturn. Many discoveries await us not only concerning the planet itself, but also from the close flybys of its moons, and a descent into the atmosphere of the large moon Titan by the Huyghens probe.

This almanac is compiled and published by Perth Observatory, Australia's oldest continuously operating astronomical observatory, in order to assist the local community enjoy the night sky. It is designed to cater for a range of levels and interest - from the complete novice to the very keen amateur. In an effort to provide the best service to the community further improvements have been made to this year's Almanac. The monthly rise and set charts more accurately reflect the date change that occurs over a night. Updates have been made to; the Solar System naming information and moon data (with the continuing discovery of new moons), Moon facts, comet ephemerides, meteor showers and Western Australian places of astronomical interest. Also, a section listing Moon occultations has been included as well as a new section outlining the ancient astronomical roots in both our systems, and terminology, of time keeping.

Early in January all the VISIBLE PLANETS are above the horizon around the start of morning civil twilight. This is a relatively rare event and the ecliptic, the path of the Earth's orbit about the Sun, is clearly defined by joining the planets with and imaginary arc across the sky. Defining the ecliptic provides some special astronomical information because the ecliptic also closely approximates the orbital paths of all the planets. Furthermore, it is only in a band along the ecliptic that you can find the planets. Planetary motion is not arbitrary – they all orbit the Sun, and the similarity of their orbital planes hints at a common process in the formation of the planets.



ALL VISIBLE PLANETS on SHOW in the EARLY MORNING SKY early JANUARY

Can you observe any celestial objects other than the Sun and Moon in the daytime? Yes, people with average eyesight should be able to detect the bright planet VENUS. But you must know its position as the glare of the daytime sky severely reduces its conspicuousness. One way to overcome this is to try to observe it when it's close to the Moon. This occurs on August 8th and October 7th. So on these dates use the Moon as a position reference and slowly scan around it in order to find Venus. Remember: ***Do NOT look at the Sun***.

VENUS VISIBLE in DAYTIME AUGUST 8 and OCTOBER 7

Need more of a challenge? Try to find JUPITER. It's about five times fainter than Venus so this is a more difficult task. Jupiter will be close to the Moon on January 4th, June 16th and August 10th. So scan around the Moon on these dates to test your eyesight and patience! Remember: ***Do NOT look at the Sun***.

JUPITER may be VISIBLE in DAYTIME JANUARY 4, JUNE 16 and AUGUST 10

Two lunar eclipses are visible from WA in 2005. In the first of these the Moon does not traverse the full shadow of the Earth and so will not become particularly dark. The second lunar eclipse will be darker because a part of the Moon traverses the full Earth shadow.

PENUMBRAL ECLIPSE of the MOON APRIL 24
PARTIAL ECLIPSE of the MOON OCTOBER 17

Thank you to all those who provided feedback regarding the 2004 Almanac. We hope we have been able to satisfy all your information needs. If we haven't - please contact us. Like last year, the author of the most helpful feedback will receive a free copy of the Western Australian Astronomy Almanac for 2006. Standard rules apply: All entries must be in writing, the judge's decision is final and no correspondence will be entered into. Final submission date for feedback is 2005 March 1.

FREE COMPETITION: The author of the most helpful feedback will receive a free copy of the Western Australian Astronomy Almanac for 2006.

Remember to spend a little time to view the night (and daytime) sky – there are many predictable and unpredictable sights to marvel at.

James Biggs, BSc (hons) PhD FRAS MAAS MIAU FASA MAIP
Government Astronomer for Western Australia,
Director of Perth Observatory,
and Adjunct Associate Professor, Curtin University of Technology.

GETTING STARTED

***Competence** requires practice. So if you want to appreciate the night sky beyond the level of simple wonderment (which we might add is a reasonable thing in itself) then you have to practice – you have to get out and observe, and prepare yourself so that you know what you are observing.*

Here are some steps that you should take in order to gain a deeper appreciation of the night sky.

Read astronomy books and other media

It's best to be prepared before you step outside to observe. This means obtaining some reliable background information about what there is to view, in which direction, what time it's visible and so on. This Almanac is a great place to start. It's designed to assist star viewing. Even when you are more expert you can consult it for the information that will assist your nights observing. There are also many websites, magazines, books, CDs and videos that can assist you. We have listed some useful websites in section: *Background & General Information* that can get you started and they also have references to resources in other media.

A planisphere is a useful tool. It has a representation of the stars and constellations visible for any night of the year. Make sure you purchase the correct one for your latitude.

One important issue in becoming familiar with the sky is size. Astronomers measure distances across the sky in degrees. We all know that in a circle there are 360°. However this is rather large and not easily applicable to star viewing. There is an easy way to estimate smaller angles. Stretch out your arm in front of you. Open your hand and extend your fingers. With your arm outstretched, the angle between the tip of your thumb and tip of your little finger is about 20°. Also, the width of your thumb is about 1 to 2°. Alternatively, the Moon provides a stationary reference being about 0.˚5 across. In fact, you can use the Moon to 'calibrate' your extended arm and hand angle measuring system.

For smaller distances across the sky, 1° is divided into 60 minutes of arc, or 60′. One minute of arc is further divided into 60 seconds of arc, or 60″. The Moon is approximately 0.˚5 or 30′ across.

These detailed units are used in the tables of accurate positions of objects in the sky, for example, see section: *Solar System Information*. Also note the way that astronomers write decimal angles – the symbol is always placed after its integer part, eg $^1/_2{}^\circ$ = 30′ = **0.˚5**, not 0.5˚. Another system to define angular positions on the sky uses time-based units: hours, minutes and seconds. This type of unit is convenient because the sky moves one rotation about every 24 hours, similar to the Sun. In this system, one complete rotation corresponds to 24 hours (denoted 24^h) and the hour is subdivided into minutes and seconds in the conventional way. Note: This system is used for positions on the sky, for example right ascension. In order to measure positional differences the system based on degrees, arc minutes and arc seconds should be used.

Join an astronomy society

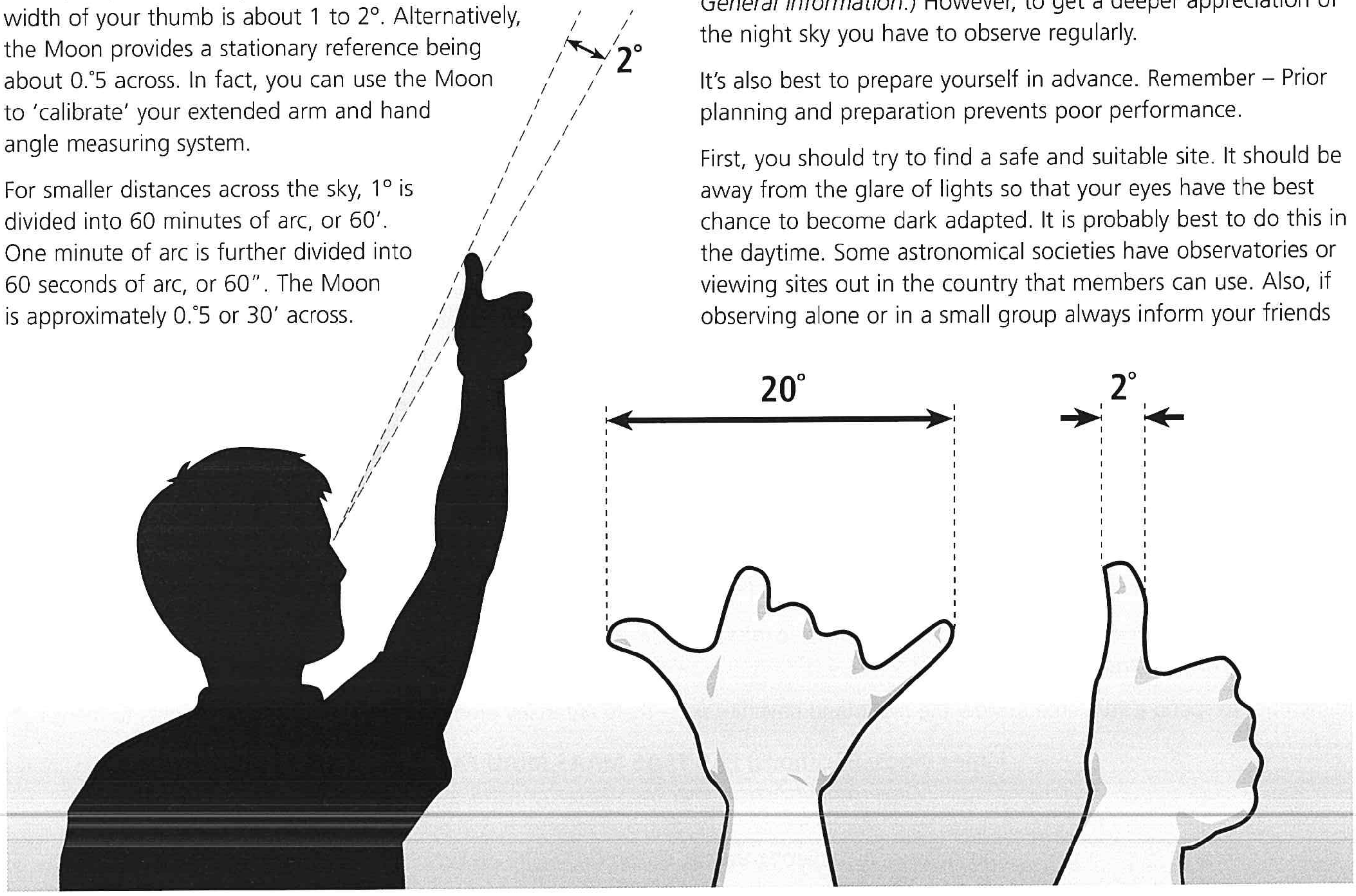
At an astronomy society you will meet a diverse range of people who have in common a great appreciation for and fascination with astronomy. The more established members are a great source of knowledge not only about the sky, but also instruments and observing sites. These societies can also provide enjoyable learning opportunities with formal and semi-formal lectures on astronomical topics, viewing nights, camps for star viewing and the like. The viewing nights also present an opportunity to learn about telescopes from the people who already own one. Some local societies are listed in section: *Western Australian Places of Astronomical Interest*.

Basic Observing

A lot of star viewing occurs incidentally, while putting out the rubbish bin, driving home late from a trip to the country and so on. You can see some spectacular sights when you least expect it. (Some of these are discussed in section: *Background & General Information*.) However, to get a deeper appreciation of the night sky you have to observe regularly.

It's also best to prepare yourself in advance. Remember – Prior planning and preparation prevents poor performance.

First, you should try to find a safe and suitable site. It should be away from the glare of lights so that your eyes have the best chance to become dark adapted. It is probably best to do this in the daytime. Some astronomical societies have observatories or viewing sites out in the country that members can use. Also, if observing alone or in a small group always inform your friends



and family and have some form of mobile communication in case of an emergency.

Read your almanacs and reference books, or run your computer programs to find out what's where and when, then make a list of things to see and do, set up at your observing site and get some equipment to make yourself comfortable such as a chair and blanket well before it gets dark. Also, it's advisable to wear stout shoes to protect your feet.

It also pays to inquire about the weather beforehand. You may need to dress warmly – you will probably be exposed to the breeze and this may create a wind chill factor that can make conditions cool even in summer. Also, star viewing is a rather low energy activity. This has the benefit that star viewing presents little restriction with regard to physical fitness - but keeping your body warm is an issue. If the weather is warm or still, insect repellent may be required.

Whilst star viewing is not a strenuous activity muscle strains can occur if your body is contorted in order to view through a telescope eyepiece or the like. In your planning think about what you will be doing. A simple folding chair may be very useful to minimise the risk of strain injuries.

Bring some spares. Batteries for your torch (very low power, or lens covered with red cellophane), spare cables etc, and food and drink for the humans!

Being organised means that there will be less need to rush and less possibility of mistakes or accidents during star viewing.

Keep it simple

Don't rush out to buy a telescope! There are a lot of telescopes that have been used once then never used again.

Become familiar with what is visible to the unaided eye. In fact, the eye is the best 'instrument' to view large sections of the sky such as those of constellation size. This also gives you an appreciation of the location of stars and constellations and at what season and time they are visible.

Objects that are visible with the unaided eye are the Moon and the five brightest planets, shooting stars (meteors), satellites, and more rarely, meteor showers, bright comets and auroras.

Optical Instruments

Binoculars are a good instrument to start with. They are mass produced and this means that generally their optical quality is quite good, and cost relatively cheap.

They come in a variety of sizes. 7 x 50 binoculars are a cost effective choice. The 7 refers to their magnification and 50 is the width of the lens in millimetres.

Binoculars need to be held steady in order to minimise image shake. This can be done by leaning up against a tree, or wall, or mounting them on a tripod.

More detail is visible when using binoculars as compared to the unaided eye. This is a simple fact of physics – the wider the aperture the more detail that can be seen. Also, fainter objects become detectable using larger collecting areas; the pupil in the human eye has an aperture of about 7mm, compared to tens of millimetres for binoculars. Sights to see with binoculars include the craters of the Moon, the moons of Jupiter, bright comets (should any be around), star clusters and vistas rich in stars especially along the Milky Way.

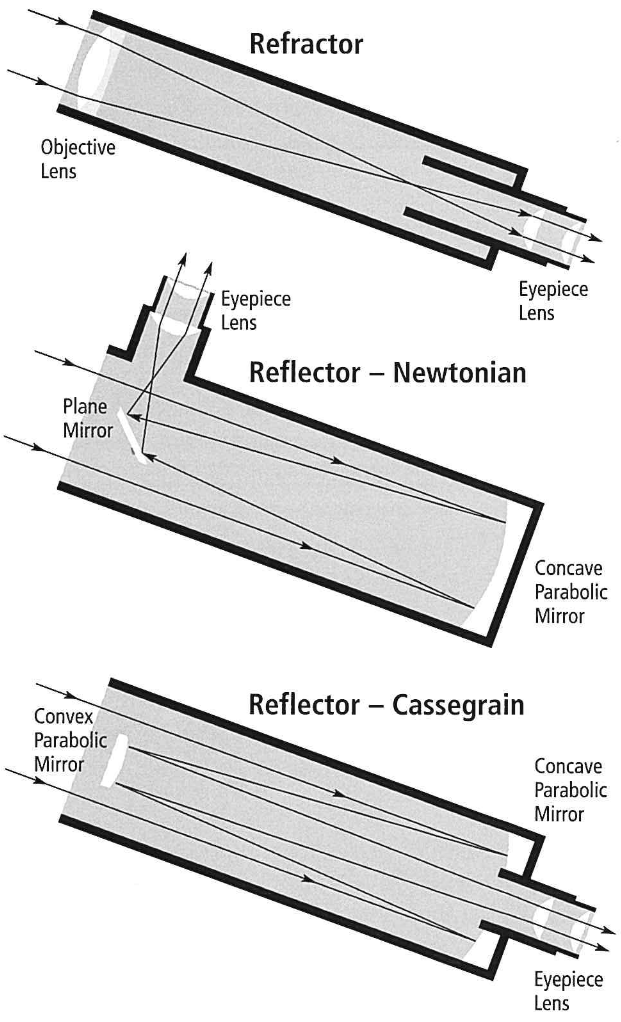
Buying a telescope

Eventually, if you've enjoyed doing all the things mentioned above you will probably want to buy your own telescope. Beware of any telescope that is advertised promoting its high magnification. These are probably built for a price, and not quality. It probably does have a high magnification, but what you will end up magnifying is the distortion in the telescope and atmosphere. Read widely about telescopes and purchase from a reputable business.

The subject of astronomical telescopes is quite large and only a very brief discussion is presented here. Telescopes come in three basic types:

- ***refractors*** – uses lenses,
- ***reflectors*** – uses a concave mirror to focus light, and
- ***catadioptrics*** – part reflecting telescope that has a correcting lens at the top to form the image. Most catadioptrics are of the Schmidt-Cassegrain design and these are quite a popular and useful design.

A sturdy mount is necessary in order to keep the image stable. A motor drive is also very useful as it allows your telescope to track celestial objects (assuming it is aligned correctly). This eliminates the tedious task of winding knobs in order to keep objects in the field of view and allows you to concentrate on astronomy.



HOW TO USE THIS ALMANAC

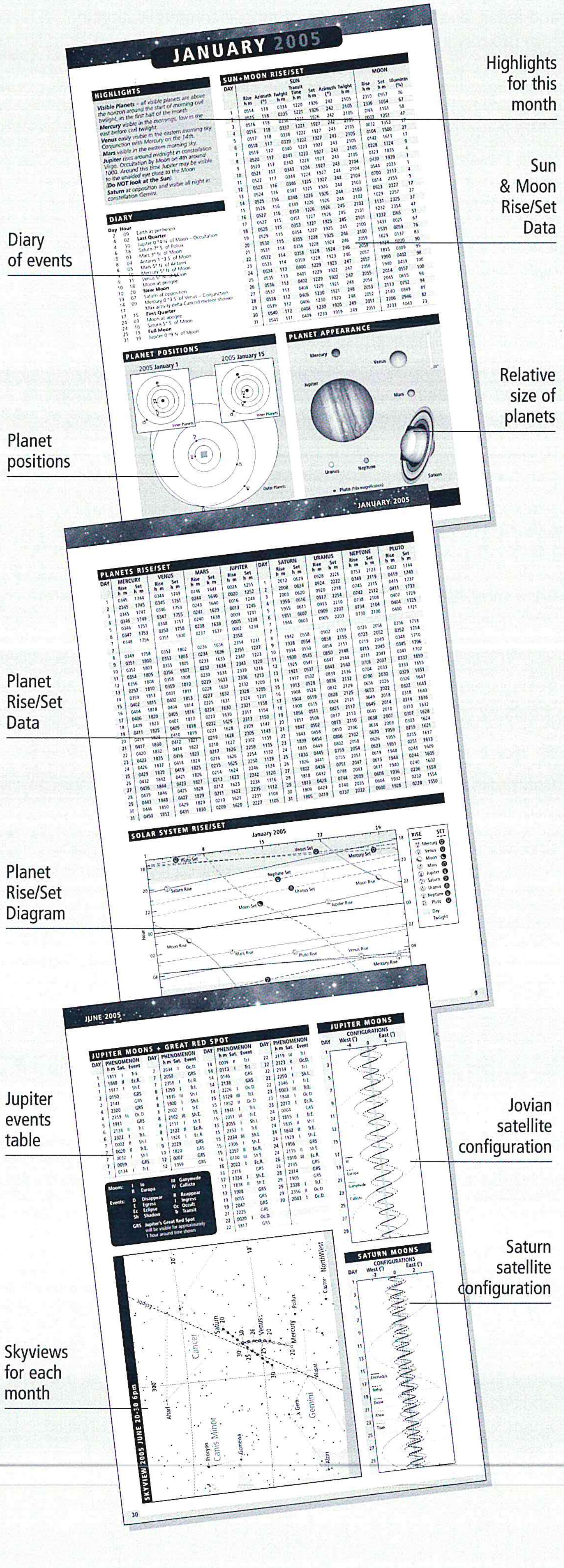
***The majority** of this almanac is dedicated to the provision of detailed information about what is to be seen and where it is located for each month. Following that is a section providing details about very rare and/or unusual events. Finally, the later sections provide background and reference information relevant for this year, as well as more general astronomical information.*

Monthly Sections

Highlights for each month and a more detailed diary of events are provided in the **monthly sections**. Also, the relative size of the planets (in seconds of arc) is illustrated graphically. In order to put the previous information in context a diagram of the inner Solar System is included for the beginning and middle of the month. The planets in the outer Solar System do not move very fast and only one plot for the middle of the month is provided for them. Detailed rise and set times for the major Solar System objects are tabulated along with other useful information such as twilight times, azimuth of sunrise and set, and the fraction of the Moon illuminated. In the table of Moon rise and set times, DNR indicates the Moon did not rise on that date, and DNS indicates the Moon did not set on that date. Note that all times are given in Western Australian Standard Times (WAST = Universal Time (formerly known as Greenwich Mean Time) + 8 hours) unless noted otherwise and twilight refers to astronomical twilight – the time when the Sun is 18° below the horizon and its glow is approximately equal to the background starlight. Sometimes the planets rise or set twice in one night – this is just a consequence of the planet's and Earth's orbital motions. A chart graphically summarises the rise and set times of the Sun, Moon and planets over a given month. All rise and set times are correct for observers in Perth, however graphs indicating the corrections required for observers elsewhere in WA are provided in section: *Background and General Information*.

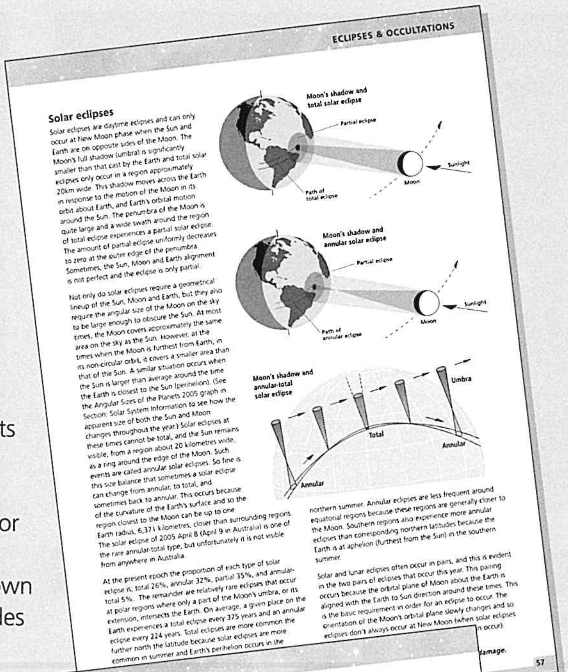
Jupiter is the next major focus of these sections. A table is provided that indicates the time of events involving its four brightest moons Io (I), Europa (II), Ganymede (III) and Callisto (IV). The events indicated are a transit (Tr, passage of moon across Jupiter), shadow (Sh, a moon's shadow crosses the disc of Jupiter), eclipse (Ec, a moon passes into Jupiter's shadow) and occultation (Oc, a moon passes behind Jupiter). The timings associated with these events are related to the disappearance (D) and reappearance (R) of a moon after an occultation, and, ingress (I) into, and egress (E) from, Jupiter's disc associated with a transit, shadow or eclipse event. Also, the times of visibility of Jupiter's Great Red Spot (GRS) are provided. In practise, it is only visible for around one hour centred on these times and is notoriously difficult to detect without stable atmospheric conditions and a decent telescope. The positions of the moons with respect to the planets Jupiter and Saturn are also illustrated graphically. Note that in these charts the thicker lines indicate that the moon is closer to Earth than the planet.

The last component of these sections is one of the most useful – the sky views – charts showing the planet or object of interest against the background of brighter stars. These are a great aid in assisting beginners find their way around the sky. Please note that the size of the Moon in these images is larger than it should be in order to aid clarity.



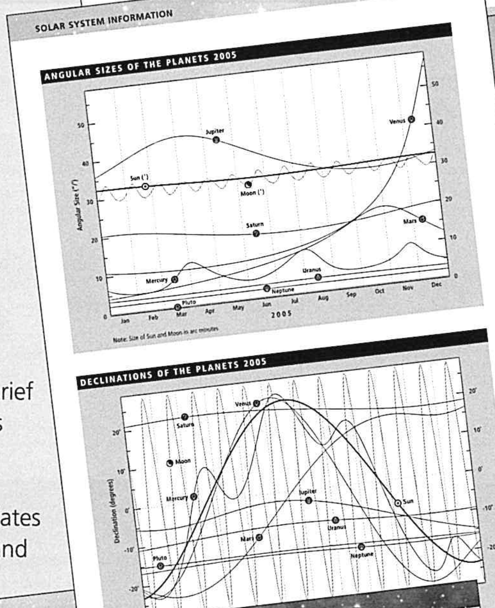
Additional Sections

Some of the more spectacular and/or rare celestial events are discussed in the **Eclipses & Occultations** Section. In particular the date, time and region where the event is actually visible are provided.


ECLIPSES & OCCULTATIONS

Solar eclipses

Detailed **Solar System information** is provided in the next section. This includes up-to-date physical parameters for the planets and their ever-increasing number of moons. Notes on the origin of the names of the planets and moons are also provided and give a flavour of the long history of astronomy and the creative continuation of its traditions. The positions of all the major Solar System objects are also tabulated. Note that these positions refer to 0000 WAST, which corresponds to 1600 UT. Charts of the planetary positions over the year are also included. The Moon's phases can affect observing so they are provided, along with a map that will aid identification of its major surface features, as well as some basic Moon information. More detailed graphs concerning the positions, sizes, brightness etc of the planets are also provided in order to assist the more experienced observers. A list of bright meteor showers visible from the Southern Hemisphere is tabulated in order to assist identification of any bright meteors. Information about close approaches by known asteroids and comets is contained in the next group of tables. Finally, ephemerides (tables of position as a function of time) for bright comets are tabulated. Note: the brightness of comets is difficult to predict with any accuracy.

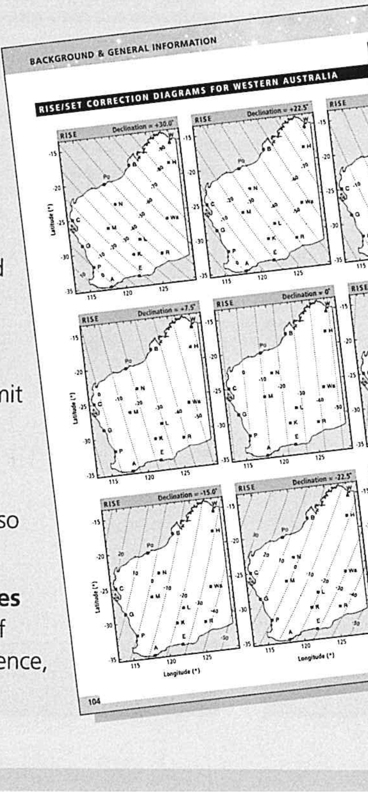

SOLAR SYSTEM INFORMATION

ANGULAR SIZES OF THE PLANETS 2005

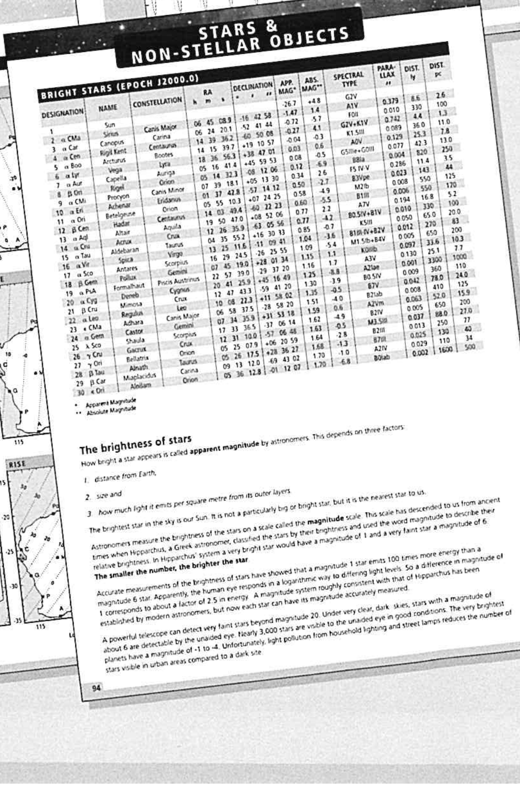
DECLINATIONS OF THE PLANETS 2005

A detailed section with explanatory notes is contained in the **Stars and Non-Stellar Objects** sections. You can't view most of these objects with the unaided eye, but they are included as a reference for those interested and the more experienced observers. The parameters provided are the most up-to-date from recent observations that were easily accessible.

The penultimate section contains a range of **Background & General Information**. The list of websites and the extensive list of astronomical definitions will be particularly useful to beginners. The subsection concerning calendars and the like may appear quiet abstract at first glance. But contained within it is information that alludes to the complex history of our (Gregorian) calendar system, and the other calendars still in use around the world. Also, a brief explanation of the astronomical and historical basis of our time keeping systems and terminology is outlined. The list of Julian day numbers is a calendar that astronomers use. Every day has a number assigned to it, and the time interval between events can be easily calculated from the difference between the two dates in Julian day format. (Try finding the time interval between, say, 1963 April 29 and 1972 November 1 without using Julian day numbers!) Also note that astronomers have an unusual format for dates and times. Not only do they use a 24 hour clock, but also they always put the most significant part first, and the least last. For example, 2pm on the 6th of July, 1990 becomes CE 1990 July 6 1400 (CE means the *Common Era*, a modern variant of AD). This system is also the international standard. A new entry in this section will aid naked-eye observers interpret, what might appear at first sight to be, unusual observations. Readers are most welcome to use the observation form provided and submit recent observations that they cannot readily identify themselves. The final page of this section shows how the Southern Cross constellation can help you find south and also assist you in determining the time.


BACKGROUND & GENERAL INFORMATION

RISE/SET CORRECTION DIAGRAMS FOR WESTERN AUSTRALIA


STARS & NON-STELLAR OBJECTS

BRIGHT STARS (EPOCH J2000.0)

The brightness of stars

The final section, **Western Australian Places of Astronomical Interest**, lists a number of places you can visit for an astronomy experience, and societies to join.

JANUARY 2005

HIGHLIGHTS

Visible Planets *– all visible planets are above the horizon around the start of morning civil twilight, in the first half of the month*

Mercury *visible in the mornings, low in the east before civil twilight.*

Venus *easily visible in the eastern morning sky. Conjunction with Mercury on the 14th.*

Mars *visible in the eastern morning sky.*

Jupiter *rises around midnight in constellation Virgo. Occultation by Moon on 4th around 1000. Around this time Jupiter may be visible to the unaided eye close to the Moon (**Do NOT look at the Sun**).*

Saturn *at opposition and visible all night in constellation Gemini.*

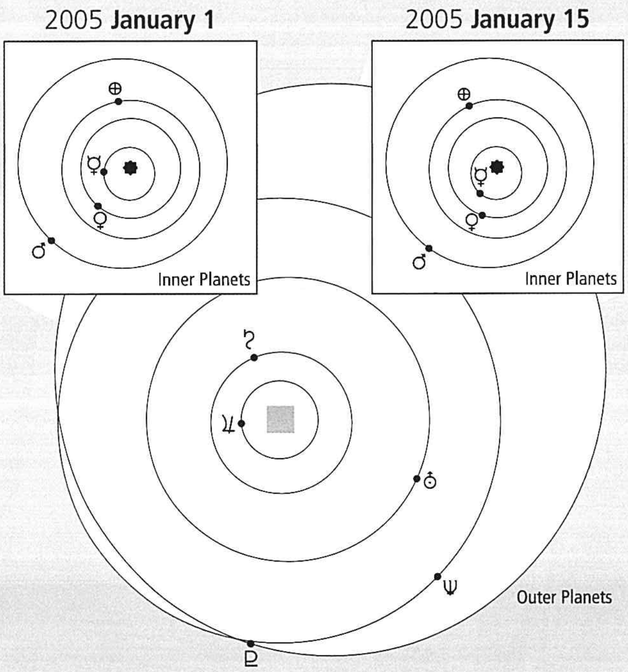
DIARY

Day	Hour	
2	09	Earth at perihelion
4	02	**Last Quarter**
4	10	Jupiter 0.°4 N. of Moon – Occultation
6	18	Saturn 7° S. of Pollux
8	03	Mars 3° N. of Moon
8	04	Antares 1.°3 S. of Moon
8	05	Mars 5° N. of Antares
9	10	Mercury 5° N. of Moon
9	11	Venus 5° N. of Moon
10	18	Moon at perigee
10	20	**New Moon**
14	07	Saturn at opposition
14	09	Mercury 0.°3 S. of Venus – Conjunction
17		Max activity delta-Cancrid meteor shower
17	15	**First Quarter**
24	03	Moon at apogee
24	16	Saturn 5° S. of Moon
25	19	**Full Moon**
31	19	Jupiter 0.°9 N. of Moon

SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0514	118	0334	1220	1926	242	2105	2310	0957	76
2	0515	118	0335	1221	1926	242	2105	2336	1054	67
3	0516	118	0336	1221	1926	242	2105	DNR	1151	58
4	0516	118	0337	1221	1927	242	2105	0003	1251	47
5	0517	118	0338	1222	1927	243	2105	0032	1353	37
6	0518	117	0339	1222	1927	243	2105	0104	1500	27
7	0519	117	0340	1223	1927	243	2105	0142	1611	17
8	0520	117	0341	1223	1927	243	2105	0228	1724	9
9	0520	117	0342	1224	1927	243	2105	0323	1835	4
10	0521	117	0343	1224	1927	243	2104	0430	1939	1
11	0522	117	0344	1224	1927	244	2104	0544	2033	1
12	0523	116	0346	1225	1927	244	2104	0700	2117	4
13	0524	116	0347	1225	1926	244	2103	0814	2155	9
14	0525	116	0348	1226	1926	244	2103	0923	2227	17
15	0526	116	0349	1226	1926	244	2102	1029	2257	27
16	0527	116	0350	1226	1926	245	2102	1131	2325	37
17	0527	115	0351	1227	1926	245	2101	1232	2354	47
18	0528	115	0353	1227	1925	245	2101	1332	DNS	57
19	0529	115	0354	1227	1925	245	2100	1431	0025	67
20	0530	115	0355	1228	1925	246	2100	1531	0059	76
21	0531	114	0356	1228	1924	246	2059	1629	0137	83
22	0532	114	0358	1228	1924	246	2058	1724	0220	90
23	0533	114	0359	1228	1923	246	2057	1815	0309	95
24	0534	113	0400	1229	1923	247	2057	1900	0402	98
25	0535	113	0401	1229	1922	247	2056	1940	0459	100
26	0536	113	0402	1229	1922	247	2055	2014	0557	100
27	0537	113	0404	1229	1921	248	2054	2045	0655	98
28	0538	112	0405	1230	1921	248	2053	2113	0752	94
29	0539	112	0406	1230	1920	248	2052	2140	0849	89
30	0540	112	0408	1230	1920	249	2051	2206	0946	82
31	0541	111	0409	1230	1919	249	2051	2233	1043	73

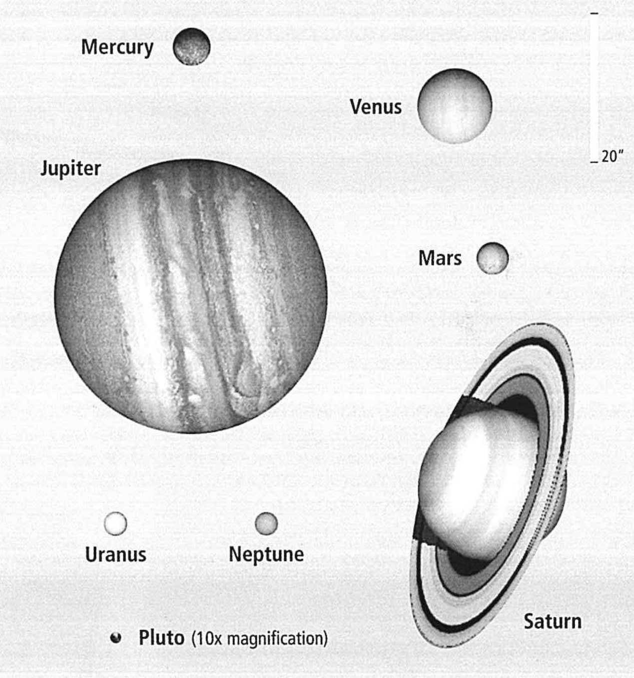
PLANET POSITIONS


2005 January 1

2005 January 15

☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

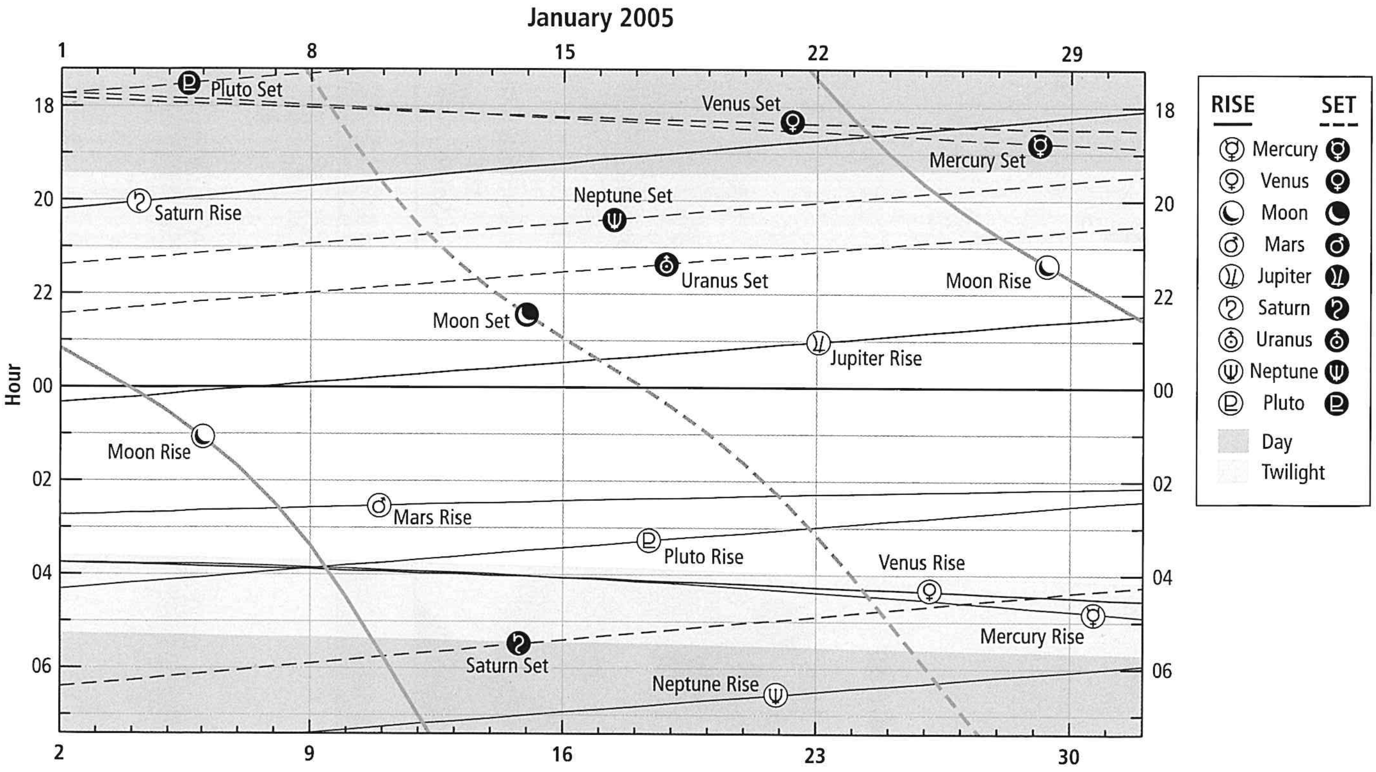


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0345	1744	0344	1749	0246	1641	0024	1255	1	2012	0629	0928	2226	0753	2123	0422	1744
2	0345	1745	0345	1751	0244	1640	0020	1252	2	2008	0624	0924	2222	0749	2119	0419	1740
3	0345	1747	0346	1753	0243	1640	0016	1248	3	2003	0620	0920	2218	0745	2115	0415	1737
4	0346	1749	0347	1755	0241	1639	0013	1245	4	1959	0616	0917	2214	0742	2112	0411	1733
5	0346	1751	0348	1757	0240	1638	0009	1241	5	1955	0611	0913	2210	0738	2108	0407	1729
6	0347	1753	0350	1758	0238	1638	0005	1238	6	1951	0607	0909	2207	0734	2104	0404	1725
7	0348	1756	0351	1800	0237	1637	0002	1234	7	1946	0603	0905	2203	0730	2100	0400	1721
7							2358		7								
8	0349	1758	0352	1802	0236	1636	2354	1231	8	1942	0558	0902	2159	0726	2056	0356	1718
9	0351	1800	0353	1803	0234	1636	2351	1227	9	1938	0554	0858	2155	0723	2052	0352	1714
10	0352	1803	0355	1805	0233	1635	2347	1223	10	1934	0550	0854	2151	0719	2049	0348	1710
11	0354	1805	0356	1807	0232	1634	2343	1220	11	1930	0545	0850	2148	0715	2045	0345	1706
12	0356	1808	0358	1808	0230	1634	2339	1216	12	1925	0541	0847	2144	0711	2041	0341	1702
13	0357	1810	0359	1810	0229	1633	2336	1213	13	1921	0537	0843	2140	0708	2037	0337	1659
14	0359	1813	0401	1811	0228	1632	2332	1209	14	1917	0532	0839	2136	0704	2033	0333	1655
15	0402	1815	0402	1813	0227	1632	2328	1205	15	1913	0528	0836	2132	0700	2030	0329	1651
16	0404	1818	0404	1814	0225	1631	2324	1201	16	1908	0524	0832	2129	0656	2026	0326	1647
17	0406	1820	0405	1816	0224	1630	2321	1158	17	1904	0519	0828	2125	0653	2022	0322	1643
18	0409	1823	0407	1817	0223	1630	2317	1154	18	1900	0515	0824	2121	0649	2018	0318	1640
19	0411	1825	0409	1818	0222	1629	2313	1150	19	1856	0511	0821	2117	0645	2014	0314	1636
20	0414	1828	0410	1819	0221	1628	2309	1147	20	1851	0506	0817	2113	0641	2010	0310	1632
21	0417	1830	0412	1821	0219	1628	2305	1143	21	1847	0502	0813	2110	0638	2007	0307	1628
22	0420	1832	0414	1822	0218	1627	2302	1139	22	1843	0458	0810	2106	0634	2003	0303	1624
23	0423	1835	0416	1823	0217	1626	2258	1135	23	1839	0454	0806	2102	0630	1959	0259	1621
24	0426	1837	0418	1824	0216	1626	2254	1132	24	1835	0449	0802	2058	0626	1955	0255	1617
25	0429	1839	0419	1825	0215	1625	2250	1128	25	1830	0445	0759	2054	0623	1951	0251	1613
26	0432	1842	0421	1826	0214	1624	2246	1124	26	1826	0441	0755	2051	0619	1948	0248	1609
27	0436	1844	0423	1827	0213	1623	2242	1120	27	1822	0436	0751	2047	0615	1944	0244	1605
28	0439	1846	0425	1828	0212	1623	2238	1116	28	1818	0432	0748	2043	0611	1940	0240	1602
29	0443	1848	0427	1829	0211	1622	2235	1112	29	1813	0428	0744	2039	0608	1936	0236	1558
30	0446	1850	0429	1829	0210	1621	2231	1108	30	1809	0423	0740	2035	0604	1932	0232	1554
31	0450	1852	0431	1830	0209	1620	2227	1105	31	1805	0419	0737	2032	0600	1928	0228	1550

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

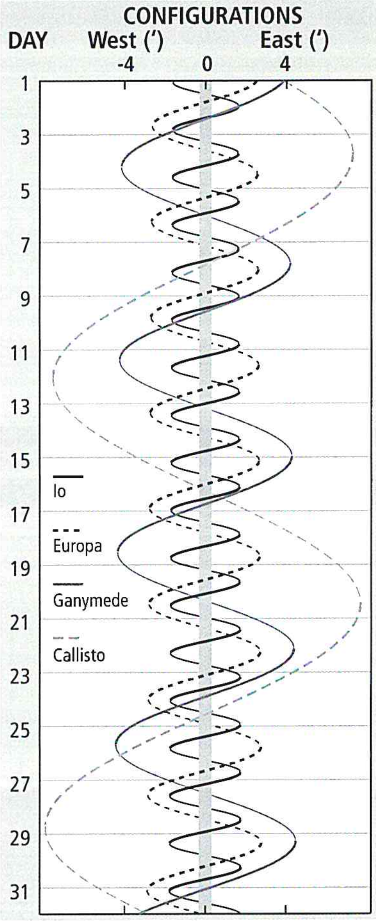
DAY	PHENOMENON h m	Sat.	Event
2	0226		GRS
2	0312	III	Sh.I.
3	0358	I	Ec.D.
4	0117	I	Sh.I.
4	0232	I	Tr.I.
4	0331	I	Sh.E.
4	0405		GRS
4	0443	I	Tr.E.
5	0152	I	Oc.R.
5	0419	II	Sh.I.
6	0054	III	Oc.R.
7	0134		GRS
7	0434	II	Oc.R.
9	0313		GRS
11	0310	I	Sh.I.
11	0425	I	Tr.I.
11	0451		GRS
12	0019	I	Ec.D.
12	0042		GRS
12	0344	I	Oc.R.
12	2352	I	Sh.E.
13	0004	III	Ec.R.
13	0105	I	Tr.E.
13	0223	III	Oc.D.
13	0449	III	Oc.R.
14	0158	II	Ec.D.
14	0221		GRS
16	0115	II	Tr.E.
16	0359		GRS
16	2328		S
18	0504	I	Sh.I.
18	0537		GRS
19	0129		GRS
19	0212	I	Ec.D.
19	2332	I	Sh.I.
20	0045	I	Tr.I.
20	0112	III	Ec.D.
20	0145	I	Sh.E.
20	0257	I	Tr.E.
20	0400	III	Ec.R.
21	0004	I	Oc.R.
21	0307		GRS
21	0433	II	Ec.D.
23	0108	II	Tr.I.
23	0125	II	Sh.E.
23	0345	II	Tr.E.
23	0445		GRS
24	0036		GRS
24	2254	II	Oc.R.
26	0215		GRS
26	0405	I	Ec.D.
27	0125	I	Sh.I.
27	0236	I	Tr.I.
27	0338	I	Sh.E.
27	0447	I	Tr.E.
27	0510	III	Ec.D.
28	0155	I	Oc.R.
28	0353		GRS
28	2315	I	Tr.E.
28	2344		GRS
30	0117	II	Sh.I.
30	0336	II	Tr.I.
30	0359	II	Sh.E.
30	0531		GRS
30	2352	III	Tr.I.
31	0122		GRS
31	0210	III	Tr.E.

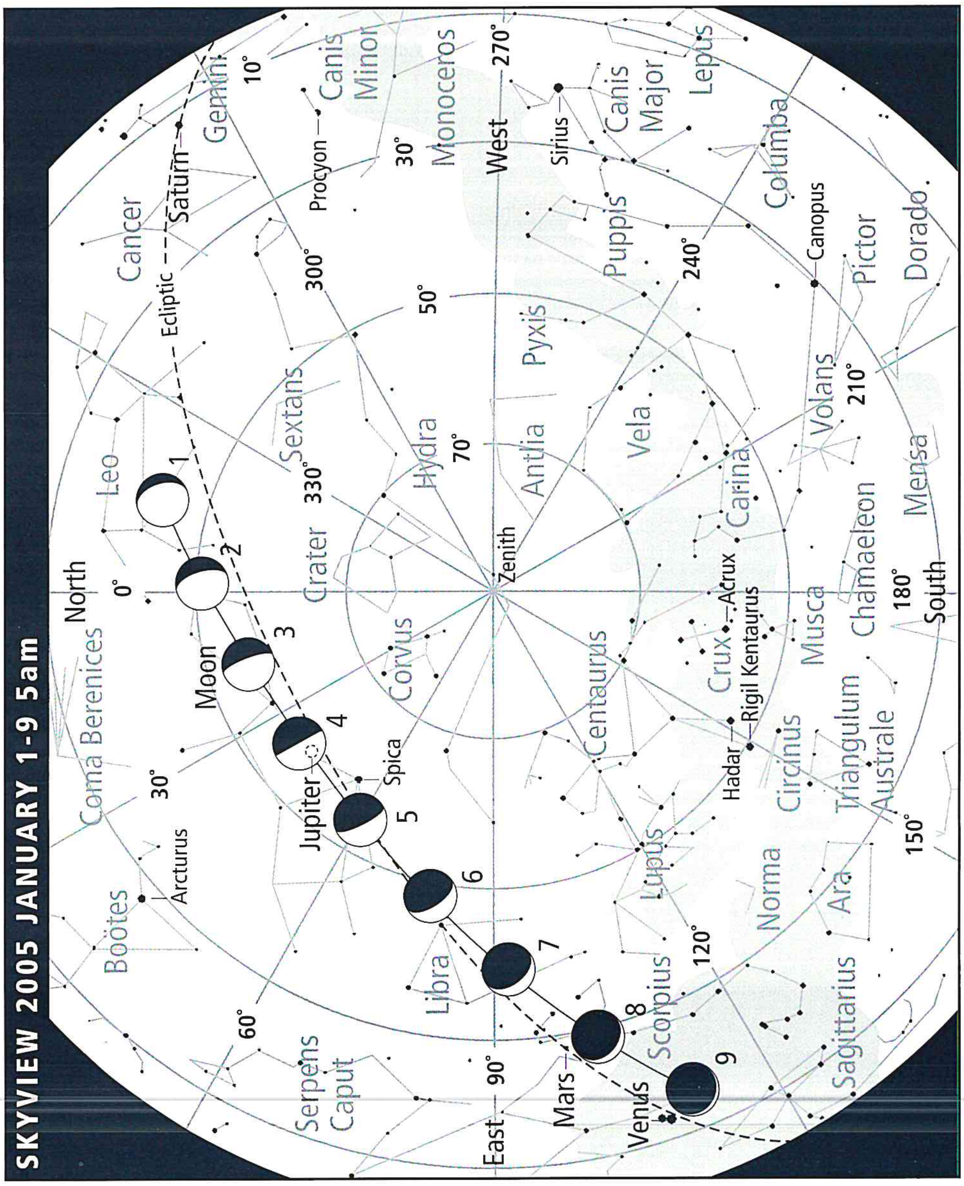
Moons:
I Io
II Europa
III Ganymede
IV Callisto

Events:
D Disappear
E Egress
Ec Eclipse
Sh Shadow
R Reappear
I Ingress
Oc Occult
Tr Transit

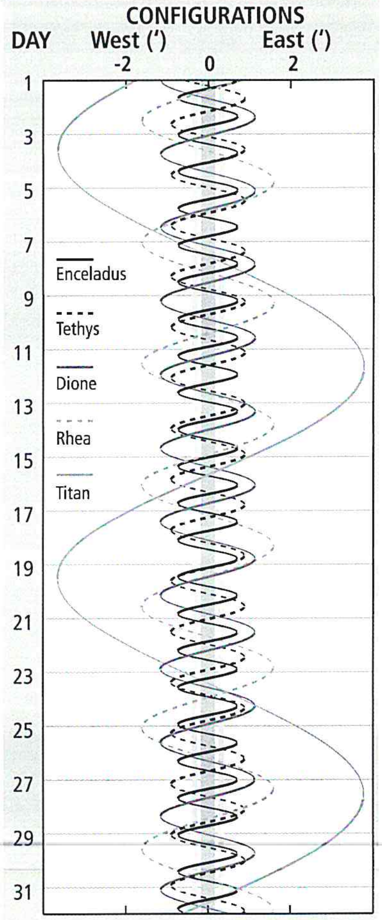
GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

JUPITER MOONS

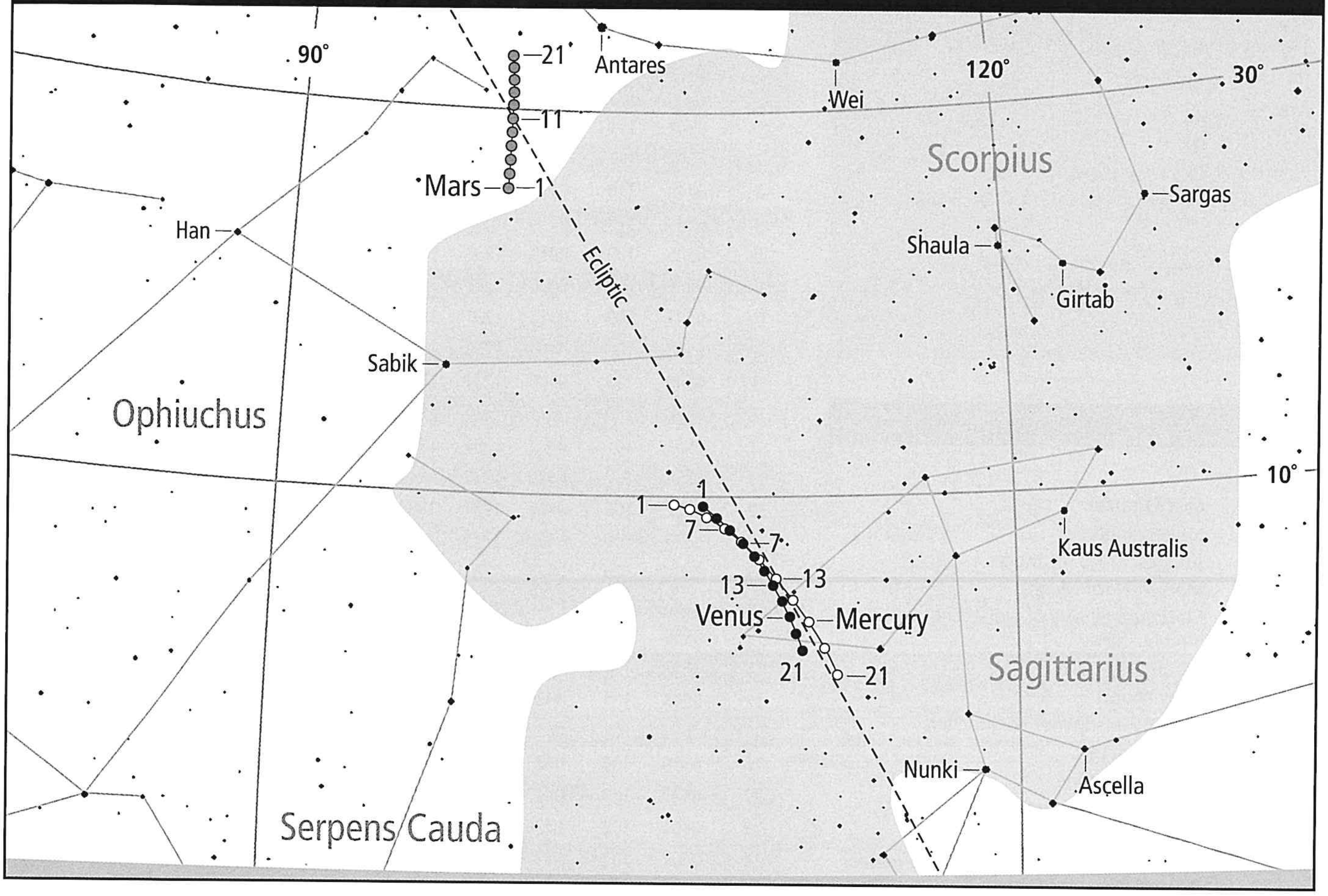



SKYVIEW 2005 JANUARY 1-9 5am

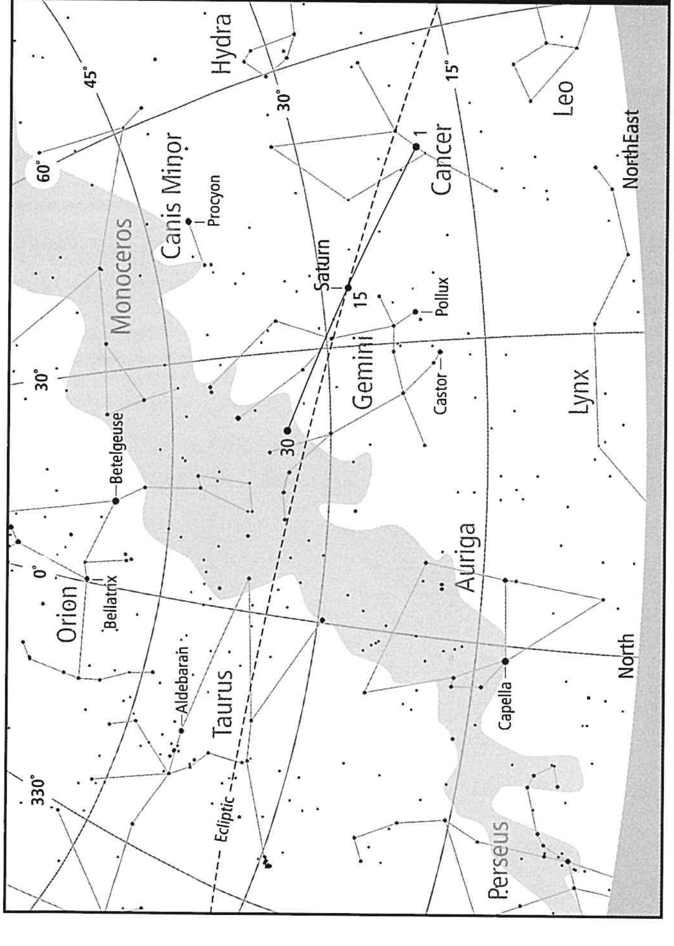
SATURN MOONS



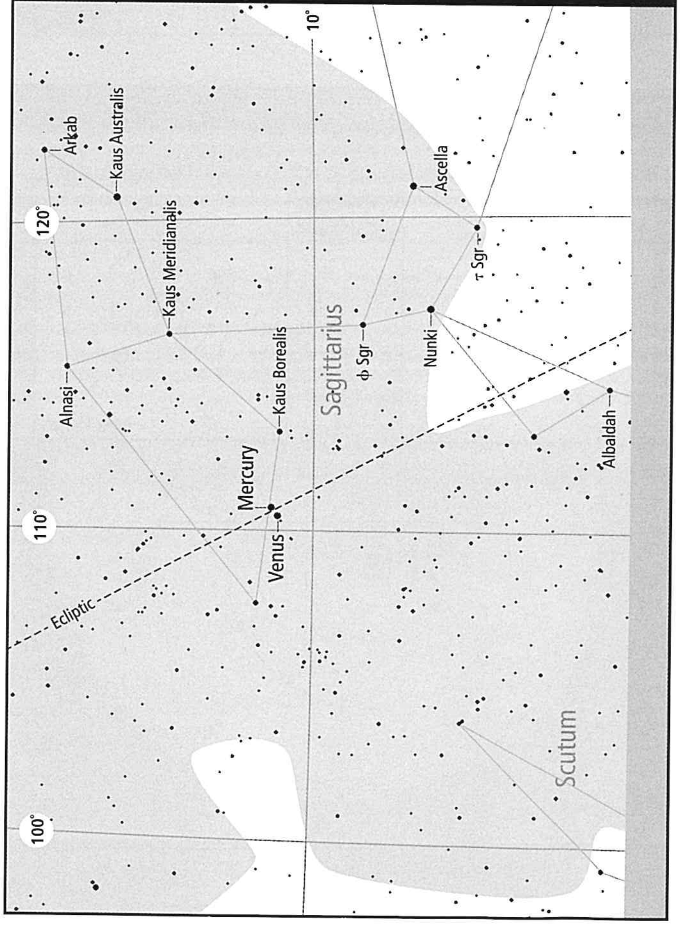
SKYVIEW 2005 JANUARY 1-21 5am



SKYVIEW 2005 JANUARY 1-30 10pm



SKYVIEW 2005 JANUARY 14 5am



FEBRUARY 2005

HIGHLIGHTS

Venus *visible in the eastern morning sky in the first half of the month.*

Mars *visible in the eastern morning sky in the constellation Sagittarius.*

Jupiter *rises well before midnight in constellation Virgo. Occultation by Moon on 27th around 2300.*

Saturn *visible all evening and part of the morning in constellation Gemini.*

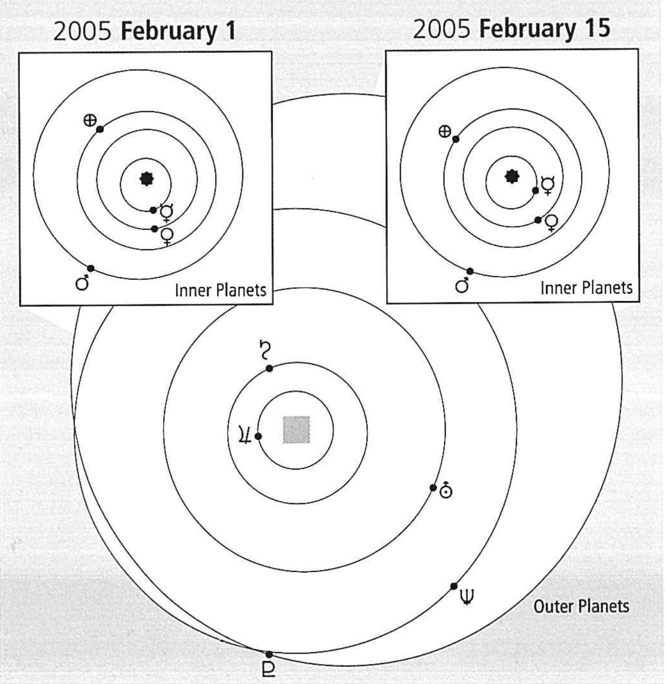
DIARY

Day	Hour	
2	15	**Last Quarter**
3	00	Jupiter stationary
4	13	Antares 1.°1 S. of Moon
5	21	Mars 4° N. of Moon
7		Maximum activity of alpha-Centaurid meteor shower
8	06	Moon at perigee
9	06	**New Moon**
14	19	Mercury in superior conjunction
16	08	**First Quarter**
20	13	Moon at apogee
20	19	Saturn 5° S. of Moon
24	13	**Full Moon**
25		Maximum activity of delta-Leonid meteor shower
27	23	Jupiter 1.°2 N. of Moon – Occultation

SUN+MOON RISE/SET

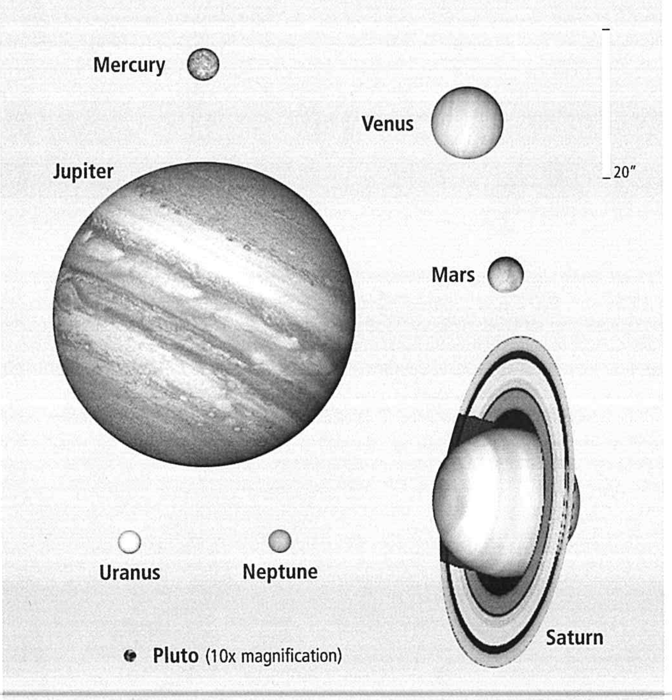
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0542	111	0410	1230	1918	249	2050	2303	1143	64
2	0542	111	0411	1230	1918	250	2049	2337	1246	54
3	0543	110	0412	1230	1917	250	2048	DNR	1353	43
4	0544	110	0414	1231	1916	250	2047	0017	1503	32
5	0545	109	0415	1231	1915	251	2045	0107	1613	22
6	0546	109	0416	1231	1915	251	2044	0206	1719	13
7	0547	109	0417	1231	1914	251	2043	0315	1816	6
8	0548	108	0419	1231	1913	252	2042	0430	1905	2
9	0549	108	0420	1231	1912	252	2041	0545	1946	0
10	0550	108	0421	1231	1911	253	2040	0659	2022	2
11	0551	107	0422	1231	1910	253	2039	0808	2054	6
12	0552	107	0423	1231	1910	253	2037	0914	2123	13
13	0552	106	0425	1231	1909	254	2036	1018	2153	21
14	0553	106	0426	1231	1908	254	2035	1120	2224	30
15	0554	106	0427	1231	1907	255	2034	1222	2257	40
16	0555	105	0428	1231	1906	255	2033	1322	2334	50
17	0556	105	0429	1231	1905	255	2031	1422	DNS	60
18	0557	104	0430	1231	1904	256	2030	1518	0016	69
19	0558	104	0431	1230	1903	256	2029	1611	0103	77
20	0559	104	0432	1230	1902	257	2028	1658	0155	85
21	0559	103	0433	1230	1901	257	2026	1739	0251	91
22	0600	103	0435	1230	1900	258	2025	1815	0349	95
23	0601	102	0436	1230	1858	258	2024	1847	0447	99
24	0602	102	0437	1230	1857	258	2022	1916	0545	100
25	0603	101	0438	1230	1856	259	2021	1943	0643	99
26	0603	101	0439	1230	1855	259	2020	2010	0740	97
27	0604	100	0440	1229	1854	260	2018	2036	0838	92
28	0605	100	0441	1229	1853	260	2017	2105	0938	86

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE



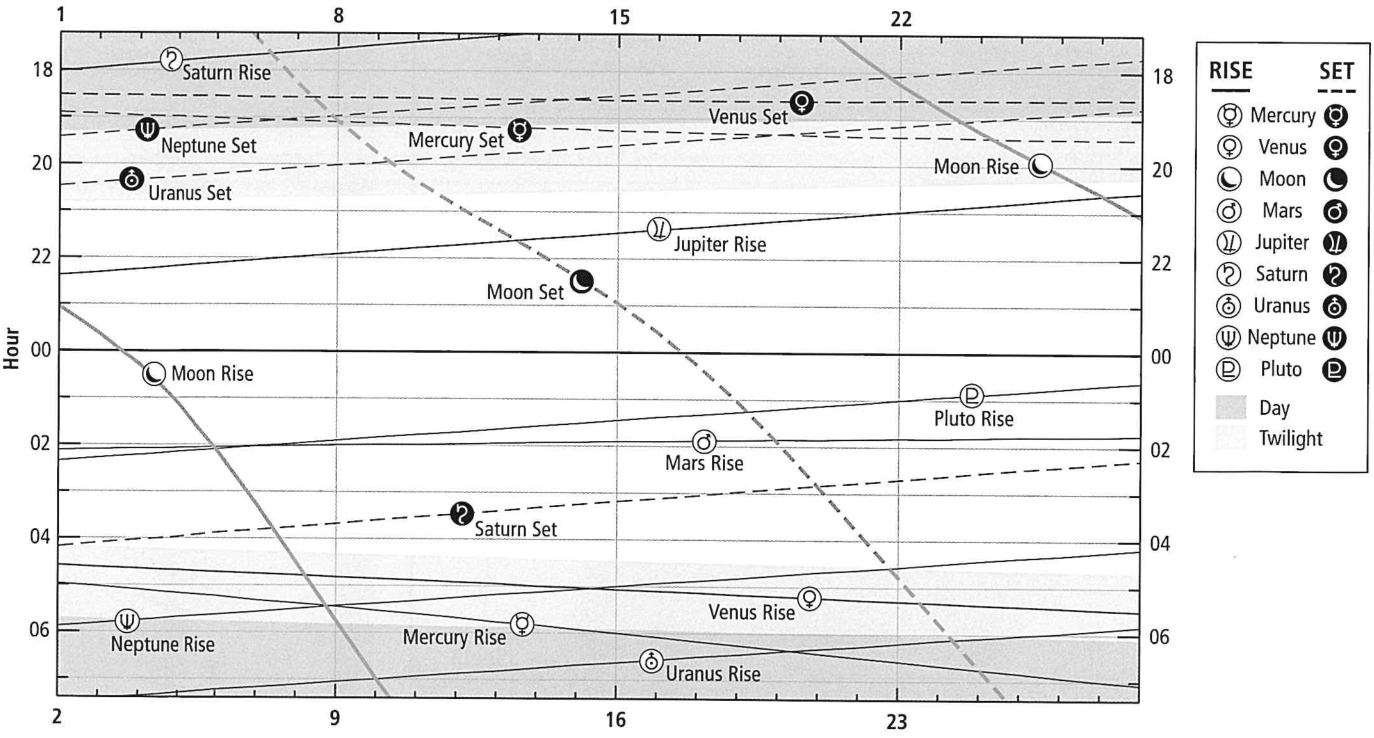
1 degree (1˚) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180˚

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0454	1854	0433	1831	0208	1620	2223	1101	1	1801	0415	0733	2028	0556	1925	0225	1546
2	0458	1856	0435	1832	0207	1619	2219	1057	2	1757	0411	0729	2024	0553	1921	0221	1543
3	0502	1858	0437	1832	0206	1618	2215	1053	3	1752	0406	0725	2020	0549	1917	0217	1539
4	0506	1859	0439	1833	0205	1617	2211	1049	4	1748	0402	0722	2017	0545	1913	0213	1535
5	0510	1901	0441	1833	0204	1616	2207	1045	5	1744	0358	0718	2013	0541	1909	0209	1531
6	0514	1903	0443	1834	0203	1616	2203	1041	6	1740	0353	0714	2009	0538	1906	0206	1527
7	0519	1904	0445	1834	0202	1615	2159	1037	7	1736	0349	0711	2005	0534	1902	0202	1523
8	0523	1906	0447	1835	0201	1614	2155	1033	8	1732	0345	0707	2001	0530	1858	0158	1520
9	0527	1907	0449	1835	0200	1613	2151	1029	9	1727	0341	0703	1958	0526	1854	0154	1516
10	0532	1909	0451	1835	0159	1612	2147	1025	10	1723	0336	0700	1954	0523	1850	0150	1512
11	0536	1910	0453	1836	0159	1611	2143	1021	11	1719	0332	0656	1950	0519	1847	0146	1508
12	0541	1912	0455	1836	0158	1611	2139	1017	12	1715	0328	0652	1946	0515	1843	0143	1504
13	0546	1913	0457	1836	0157	1610	2135	1013	13	1711	0324	0649	1943	0511	1839	0139	1500
14	0550	1914	0500	1836	0156	1609	2131	1008	14	1707	0319	0645	1939	0508	1835	0135	1457
15	0555	1916	0502	1837	0155	1608	2127	1004	15	1702	0315	0641	1935	0504	1831	0131	1453
16	0600	1917	0504	1837	0154	1607	2123	1000	16	1658	0311	0638	1931	0500	1828	0127	1449
17	0605	1918	0506	1837	0154	1606	2119	0956	17	1654	0307	0634	1927	0456	1824	0123	1445
18	0610	1919	0508	1837	0153	1605	2115	0952	18	1650	0303	0630	1924	0453	1820	0120	1441
19	0615	1920	0510	1837	0152	1604	2111	0948	19	1646	0258	0627	1920	0449	1816	0116	1437
20	0620	1921	0512	1837	0151	1603	2107	0943	20	1642	0254	0623	1916	0445	1812	0112	1433
21	0625	1922	0514	1837	0151	1602	2103	0939	21	1638	0250	0619	1912	0441	1808	0108	1430
22	0630	1923	0516	1836	0150	1601	2059	0935	22	1633	0246	0616	1909	0438	1805	0104	1426
23	0635	1923	0518	1836	0149	1600	2055	0931	23	1629	0242	0612	1905	0434	1801	0100	1422
24	0640	1924	0520	1836	0149	1559	2051	0927	24	1625	0238	0608	1901	0430	1757	0056	1418
25	0645	1925	0522	1836	0148	1558	2047	0922	25	1621	0233	0605	1857	0426	1753	0053	1414
26	0650	1925	0524	1836	0147	1557	2042	0918	26	1617	0229	0601	1854	0422	1749	0049	1410
27	0655	1926	0526	1835	0147	1556	2038	0914	27	1613	0225	0558	1850	0419	1746	0045	1406
28	0700	1926	0528	1835	0146	1555	2034	0910	28	1609	0221	0554	1846	0415	1742	0041	1402

SOLAR SYSTEM RISE/SET

February 2005



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON		
	h m	Satellite	Event
1	0122	II	Oc.R.
2	0300		GRS
2	2252		GRS
3	0319	I	Sh.I.
3	0426	I	Tr.I.
3	0531	I	Sh.E.
4	0026	I	Ec.D.
4	0344	I	Oc.R.
4	0439		GRS
4	2254	I	Tr.I.
5	0000	I	Sh.E.
5	0030		GRS
5	0104	I	Tr.E.
5	2211	I	Oc.R.
6	0350	II	Sh.I.
6	2300	III	Sh.I.
7	0145	III	Sh.E.
7	0208		GRS
7	0334	III	Tr.I.
7	2300	II	Ec.D.
8	0348	II	Oc.R.
9	0346		GRS
9	2152	II	Tr.E.
9	2337		GRS
10	0512	I	Sh.I.
11	0219	I	Ec.D.
11	0524		GRS
11	0533	I	Oc.R.
11	2340	I	Sh.I.
12	0042	I	Tr.I.
12	0115		GRS
12	0153	I	Sh.E.
12	0253	I	Tr.E.
13	0000	I	Oc.R.
14	0253		GRS
14	0258	III	Sh.I.
14	0542	III	Sh.E.
14	2245		GRS
15	0135	II	Ec.D.
16	0431		GRS
16	2138	II	Tr.I.
16	2223	II	Sh.E.
17	0015	II	Tr.E.
17	0023		GRS
17	2319	III	Oc.R.
18	0413	I	Ec.D.
18	0609		GRS
19	0134	I	Sh.I.
19	0201		GRS
19	0230	I	Tr.I.
19	0346	I	Sh.E.
19	0440	I	Tr.E.
19	2152		GRS
19	2241	I	Ec.D.
20	0147	I	Oc.R.
20	2214	I	Sh.E.
20	2307	I	Tr.E.
21	0339		GRS
21	2330		GRS
22	0409	II	Ec.D.
23	0517		GRS
23	2216	II	Sh.I.
24	0000	II	Tr.I.
24	0058	II	Sh.E.
24	0108		GRS
24	0236	II	Tr.E.
24	2100	III	Ec.D.
24	2343	III	Ec.R.
25	0034	III	Oc.D.
25	0248	III	Oc.R.
25	2142	II	Oc.R.
26	0246		GRS
26	0327	I	Sh.I.
26	0416	I	Tr.I.
26	0539	I	Sh.E.
26	2237		GRS
27	0034	I	Ec.D.
27	0333	I	Oc.R.
27	2155	I	Sh.I.
27	2242	I	Tr.I.
28	0008	I	Sh.E.
28	0053	I	Tr.E.
28	0424		GRS
28	2200	I	Oc.R.

Moons:

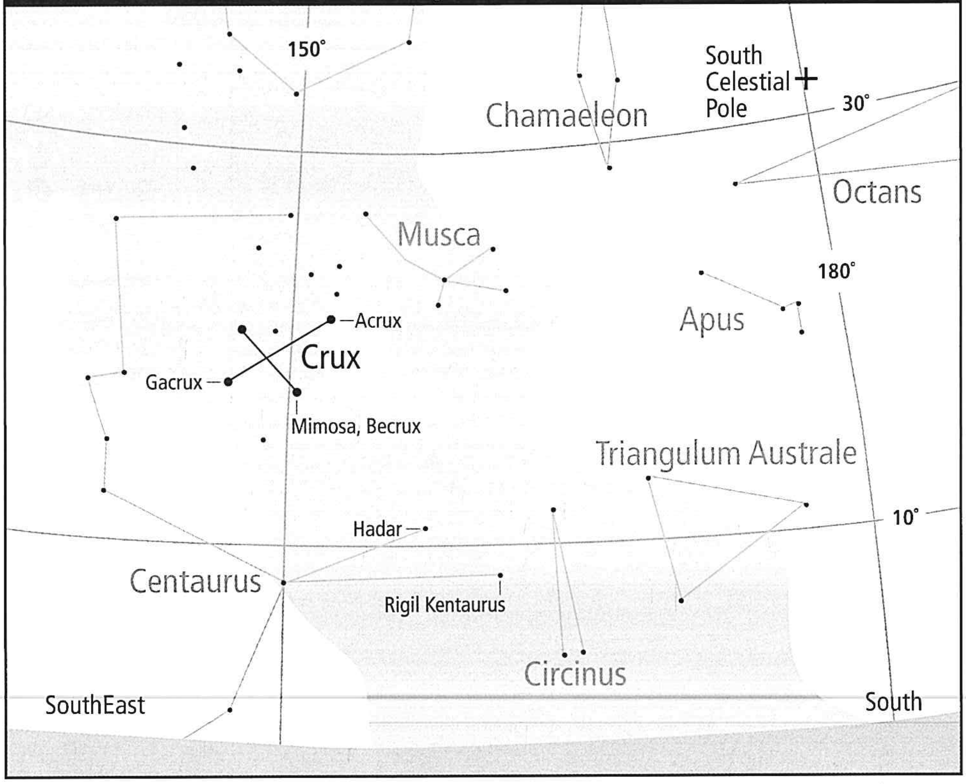
I	Io	III	Ganymede
II	Europa	IV	Callisto

Events:

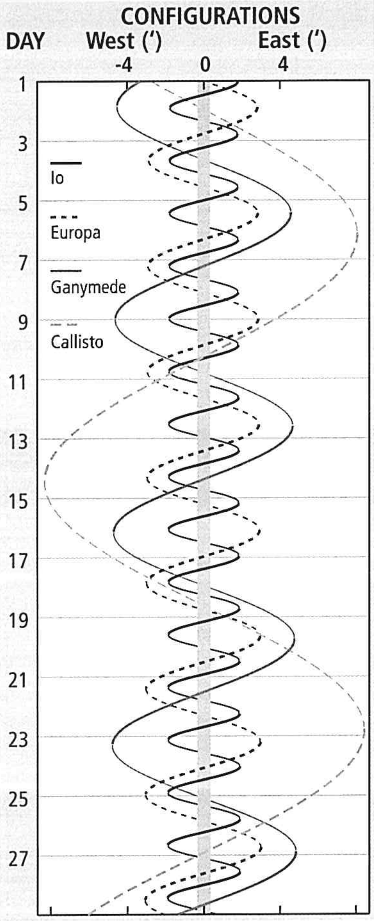
D	Disappear	R	Reappear
E	Egress	I	Ingress
Ec	Eclipse	Oc	Occult
Sh	Shadow	Tr	Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

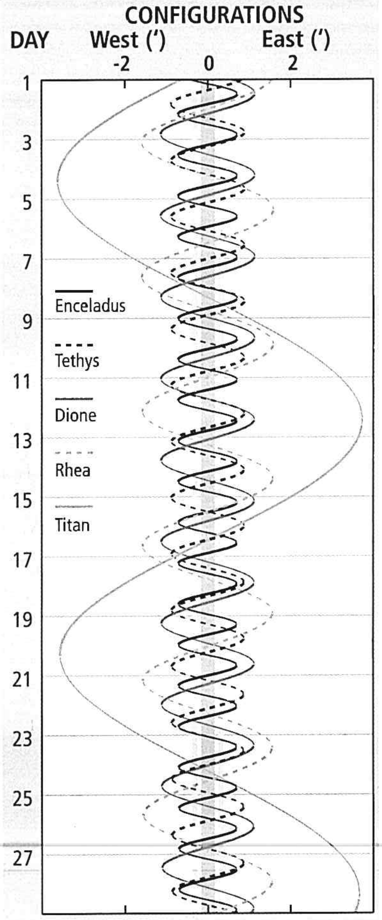
SKYVIEW FEBRUARY 15 8pm – SOUTHERN CROSS



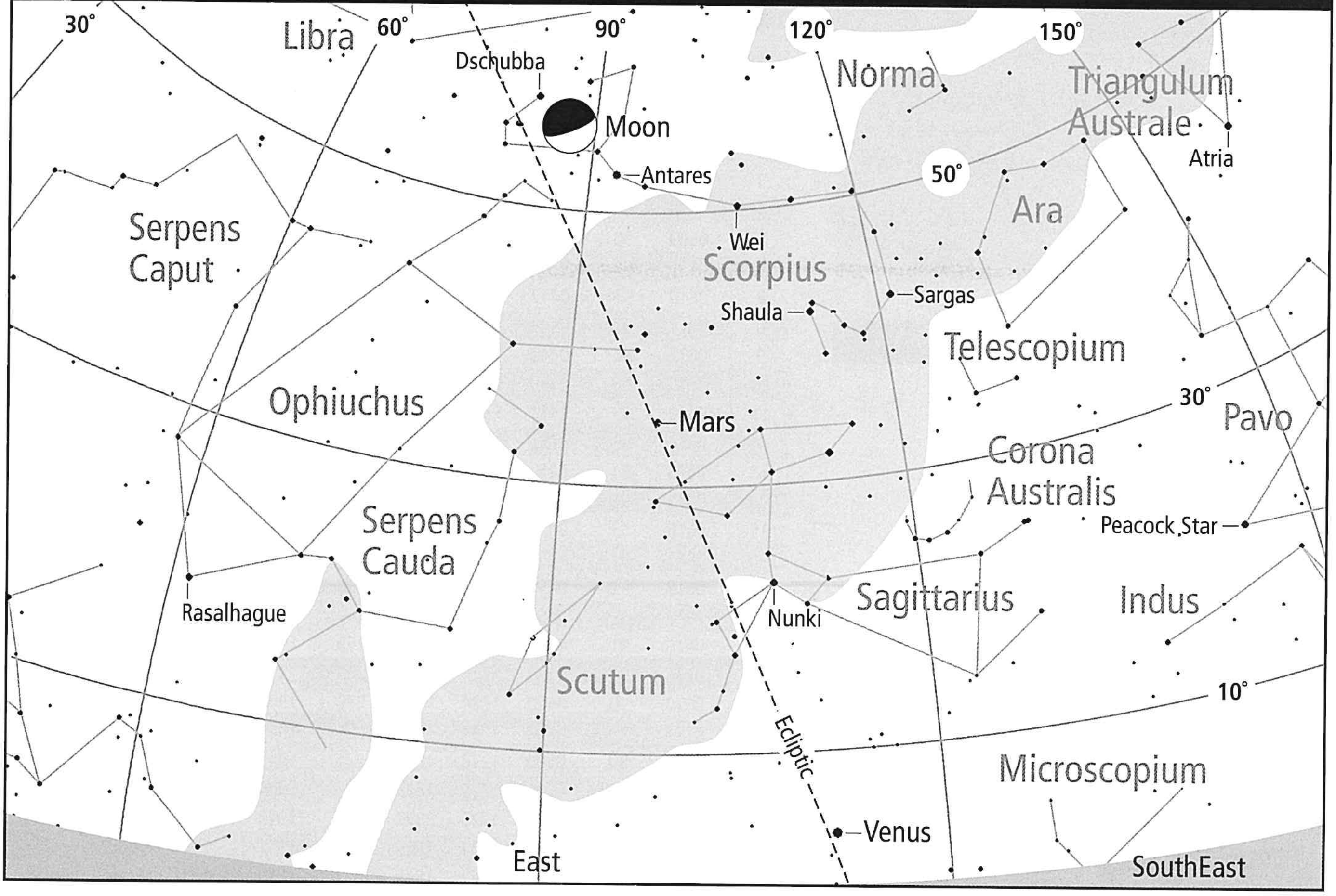
JUPITER MOONS



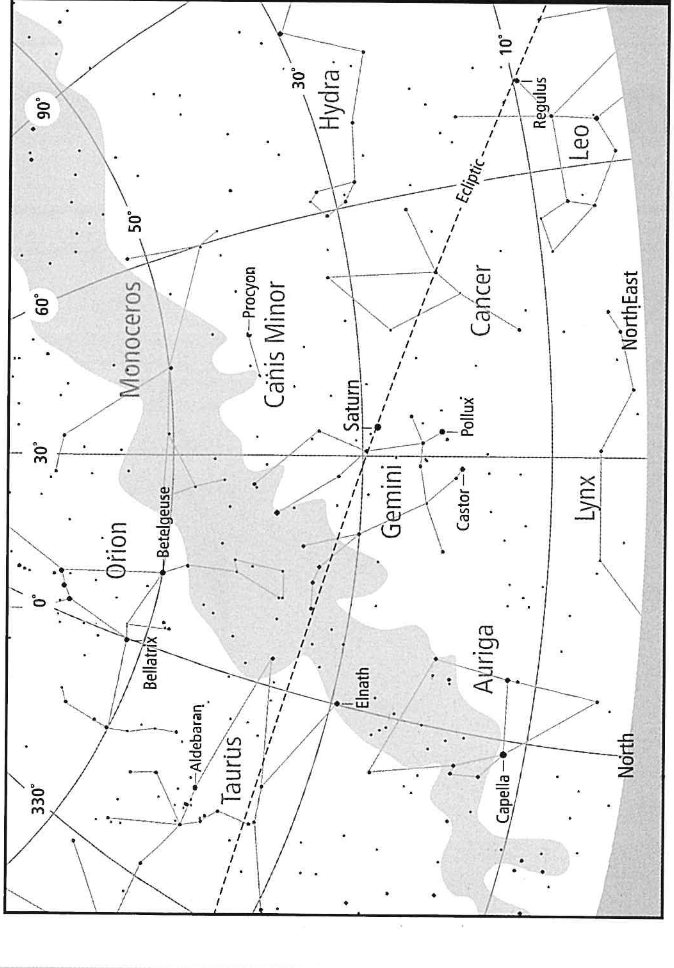
SATURN MOONS



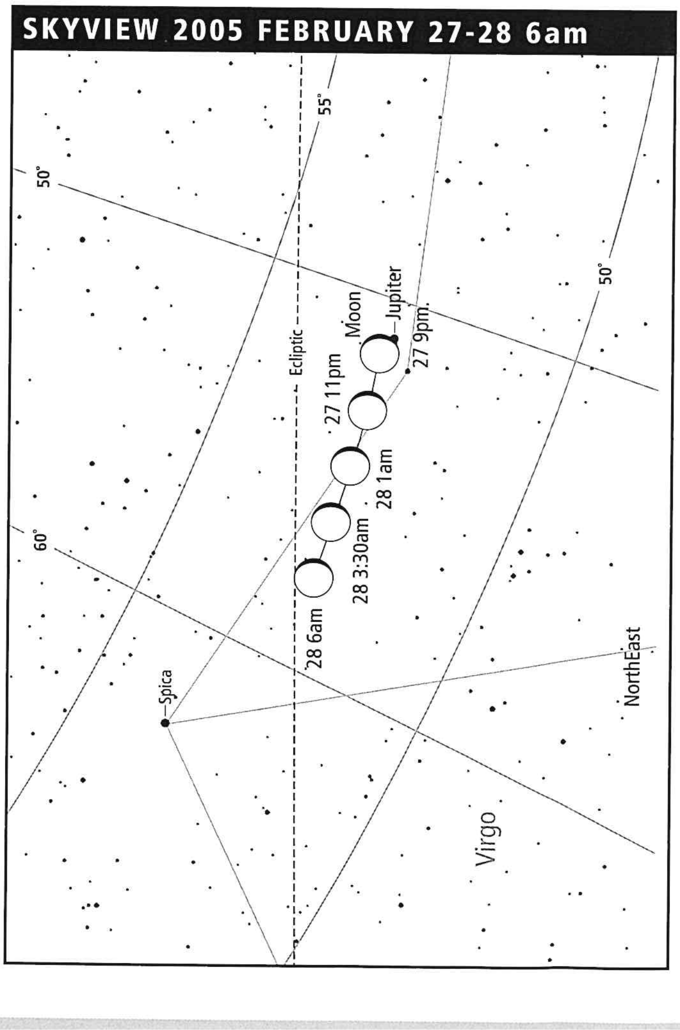
SKYVIEW 2005 FEBRUARY 4 5am



SKYVIEW 2005 FEBRUARY 15 10pm



SKYVIEW 2005 FEBRUARY 27-28 6am



MARCH 2005

HIGHLIGHTS

Mercury *visible in the western evening sky after civil twilight.*

Mars *visible in the eastern morning sky.*

Jupiter *rises not long after sunset in constellation Virgo. Occultation by Moon on 27th around midnight.*

Saturn *visible all evening and part of the morning in constellation Gemini.*

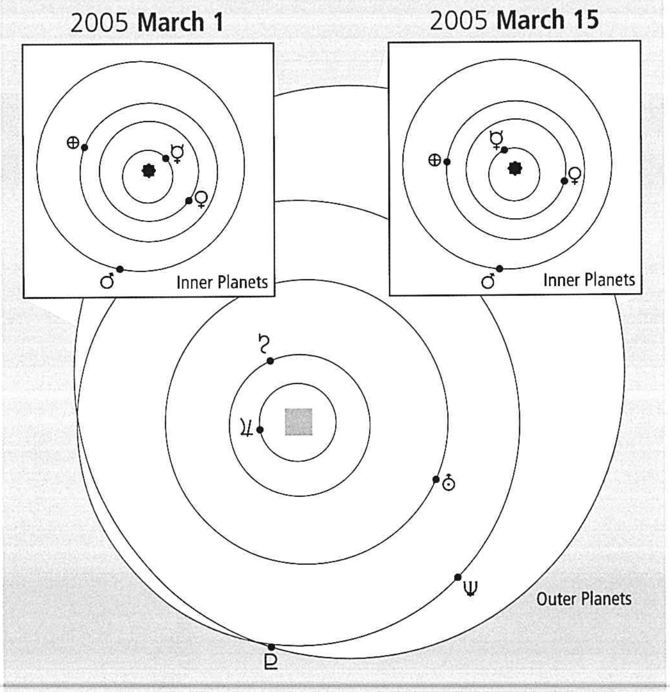
DIARY

Day	Hour	
3	19	Antares 0.°8 S. of Moon
4	02	**Last Quarter**
6	14	Mars 5° N. of Moon
8	12	Moon at perigee
10	17	**New Moon**
12	00	Mercury 3° N. of Moon
13		Maximum activity of gamma-Normid meteor shower
13	02	Mercury greatest elongation E (18°)
18	03	**First Quarter**
20	00	Mercury stationary
20	00	Saturn 5° S. of Moon
20	07	Moon at apogee
20	21	Equinox
22	08	Saturn stationary
24		Maximum activity of Virginid meteor shower
26	05	**Full Moon**
27	00	Jupiter 1.°5 N. of Moon – Occultation
27	16	Pluto stationary
30	00	Mercury in inferior conjunction
31	01	Antares 0.°7 S. of Moon
31	11	Venus in superior conjunction

SUN+MOON RISE/SET

DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0606	100	0442	1229	1852	261	2016	2137	1040	78
2	0607	99	0443	1229	1850	261	2014	2215	1145	69
3	0607	99	0444	1229	1849	262	2013	2300	1252	58
4	0608	98	0445	1228	1848	262	2011	2353	1400	47
5	0609	98	0445	1228	1847	262	2010	DNR	1506	36
6	0610	97	0446	1228	1846	263	2009	0056	1605	25
7	0610	97	0447	1228	1844	263	2007	0207	1656	16
8	0611	96	0448	1227	1843	264	2006	0320	1739	8
9	0612	96	0449	1227	1842	264	2005	0433	1816	3
10	0613	95	0450	1227	1841	265	2003	0544	1849	0
11	0613	95	0451	1227	1839	265	2002	0652	1920	1
12	0614	95	0452	1226	1838	266	2000	0758	1949	4
13	0615	94	0452	1226	1837	266	1959	0902	2020	9
14	0615	94	0453	1226	1836	267	1958	1005	2053	16
15	0616	93	0454	1226	1834	267	1956	1108	2129	24
16	0617	93	0455	1225	1833	268	1955	1210	2210	33
17	0618	92	0456	1225	1832	268	1954	1309	2255	42
18	0618	92	0457	1225	1831	269	1952	1404	2346	52
19	0619	91	0457	1224	1829	269	1951	1453	DNS	61
20	0620	91	0458	1224	1828	269	1950	1537	0041	70
21	0620	90	0459	1224	1827	270	1948	1615	0139	79
22	0621	90	0500	1224	1826	270	1947	1648	0237	86
23	0622	89	0500	1223	1824	271	1945	1718	0335	92
24	0622	89	0501	1223	1823	271	1944	1746	0433	96
25	0623	88	0502	1223	1822	272	1943	1812	0531	99
26	0624	88	0503	1222	1820	272	1941	1839	0630	100
27	0624	88	0503	1222	1819	273	1940	1907	0729	99
28	0625	87	0504	1222	1818	273	1939	1939	0832	95
29	0626	87	0505	1221	1817	274	1938	2015	0937	89
30	0626	86	0505	1221	1815	274	1936	2057	1045	82
31	0627	86	0506	1221	1814	275	1935	2148	1153	72

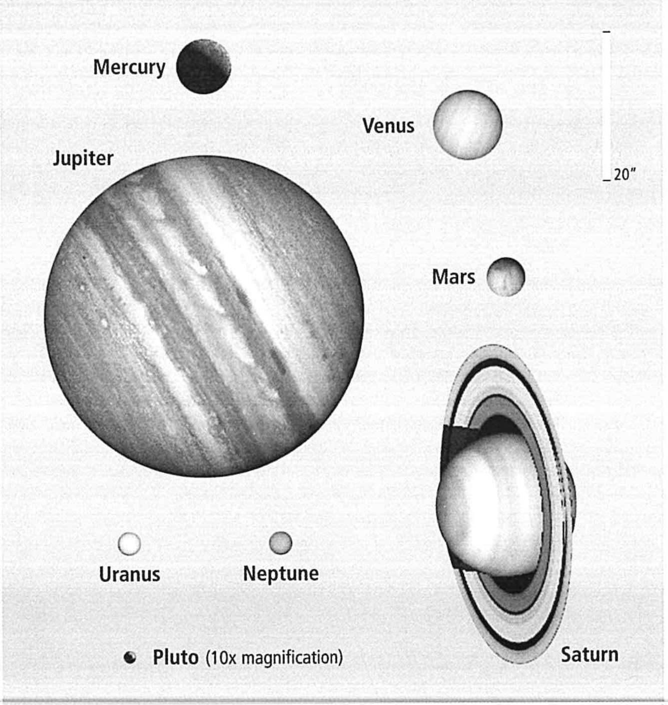
PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto

♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE



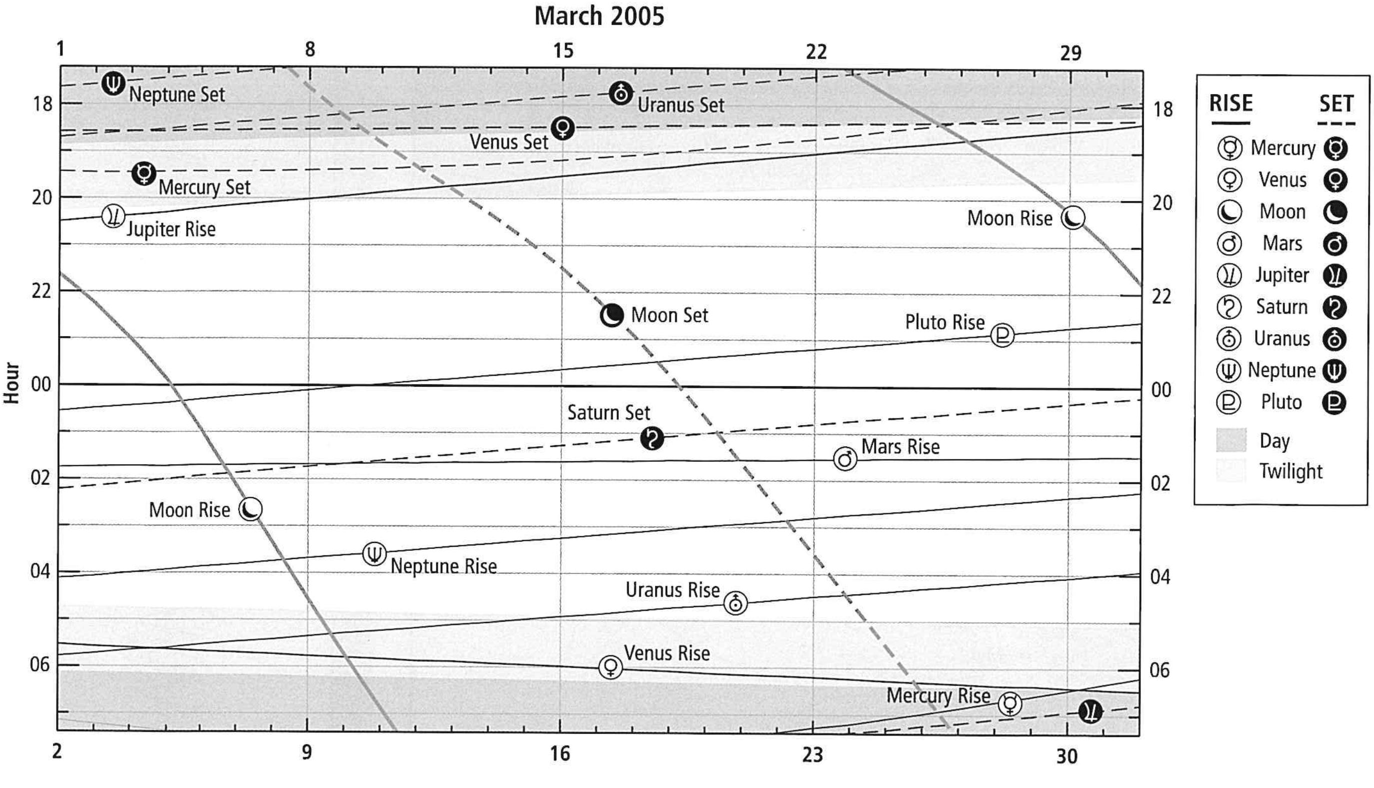
1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)

Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0704	1926	0530	1835	0145	1554	2030	0905	1	1605	0217	0550	1842	0411	1738	0037	1359
2	0709	1927	0532	1834	0145	1553	2026	0901	2	1601	0213	0547	1838	0407	1734	0033	1355
3	0714	1927	0534	1834	0144	1552	2022	0857	3	1557	0209	0543	1835	0404	1730	0029	1351
4	0718	1926	0536	1834	0143	1551	2018	0852	4	1553	0205	0539	1831	0400	1726	0026	1347
5	0722	1926	0538	1833	0143	1550	2013	0848	5	1549	0200	0536	1827	0356	1723	0022	1343
6	0726	1926	0540	1833	0142	1549	2009	0844	6	1545	0156	0532	1823	0352	1719	0018	1339
7	0730	1925	0542	1832	0142	1548	2005	0839	7	1541	0152	0528	1820	0349	1715	0014	1335
8	0733	1924	0544	1832	0141	1547	2001	0835	8	1537	0148	0525	1816	0345	1711	0010	1331
9	0736	1923	0546	1831	0141	1545	1957	0830	9	1532	0144	0521	1812	0341	1707	0006	1327
10	0738	1922	0548	1831	0140	1544	1952	0826	10	1528	0140	0517	1808	0337	1703	0002	1324
10									10							2358	
11	0740	1920	0550	1830	0139	1543	1948	0822	11	1524	0136	0514	1804	0334	1700	2354	1320
12	0742	1918	0552	1830	0139	1542	1944	0817	12	1520	0132	0510	1801	0330	1656	2351	1316
13	0743	1916	0553	1829	0138	1541	1940	0813	13	1516	0128	0506	1757	0326	1652	2347	1312
14	0743	1913	0555	1829	0138	1539	1936	0808	14	1512	0124	0503	1753	0322	1648	2343	1308
15	0743	1911	0557	1828	0137	1538	1931	0804	15	1509	0120	0459	1749	0318	1644	2339	1304
16	0742	1907	0559	1828	0137	1537	1927	0759	16	1505	0116	0455	1746	0315	1640	2335	1300
17	0740	1904	0601	1827	0136	1536	1923	0755	17	1501	0112	0452	1742	0311	1637	2331	1256
18	0738	1900	0603	1826	0136	1534	1919	0750	18	1457	0108	0448	1738	0307	1633	2327	1252
19	0735	1856	0605	1826	0135	1533	1914	0746	19	1453	0104	0444	1734	0303	1629	2323	1248
20	0732	1852	0607	1825	0135	1532	1910	0741	20	1449	0100	0441	1731	0259	1625	2319	1244
21	0728	1847	0609	1824	0134	1530	1906	0737	21	1445	0056	0437	1727	0256	1621	2315	1241
22	0723	1843	0610	1824	0134	1529	1902	0732	22	1441	0052	0433	1723	0252	1617	2312	1237
23	0717	1838	0612	1823	0133	1528	1857	0728	23	1437	0048	0429	1719	0248	1614	2308	1233
24	0712	1832	0614	1823	0133	1526	1853	0723	24	1433	0044	0426	1715	0244	1610	2304	1229
25	0705	1827	0616	1822	0132	1525	1849	0719	25	1429	0040	0422	1712	0241	1606	2300	1225
26	0658	1821	0618	1821	0132	1524	1845	0714	26	1425	0037	0418	1708	0237	1602	2256	1221
27	0651	1816	0620	1821	0131	1522	1840	0710	27	1421	0033	0415	1704	0233	1558	2252	1217
28	0643	1810	0622	1820	0131	1521	1836	0705	28	1417	0029	0411	1700	0229	1554	2248	1213
29	0636	1805	0623	1819	0130	1519	1832	0701	29	1414	0025	0407	1656	0225	1551	2244	1209
30	0628	1759	0625	1819	0130	1518	1828	0656	30	1410	0021	0404	1653	0221	1547	2240	1205
31	0620	1754	0627	1818	0129	1517	1823	0652	31	1406	0017	0400	1649	0218	1543	2236	1201

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

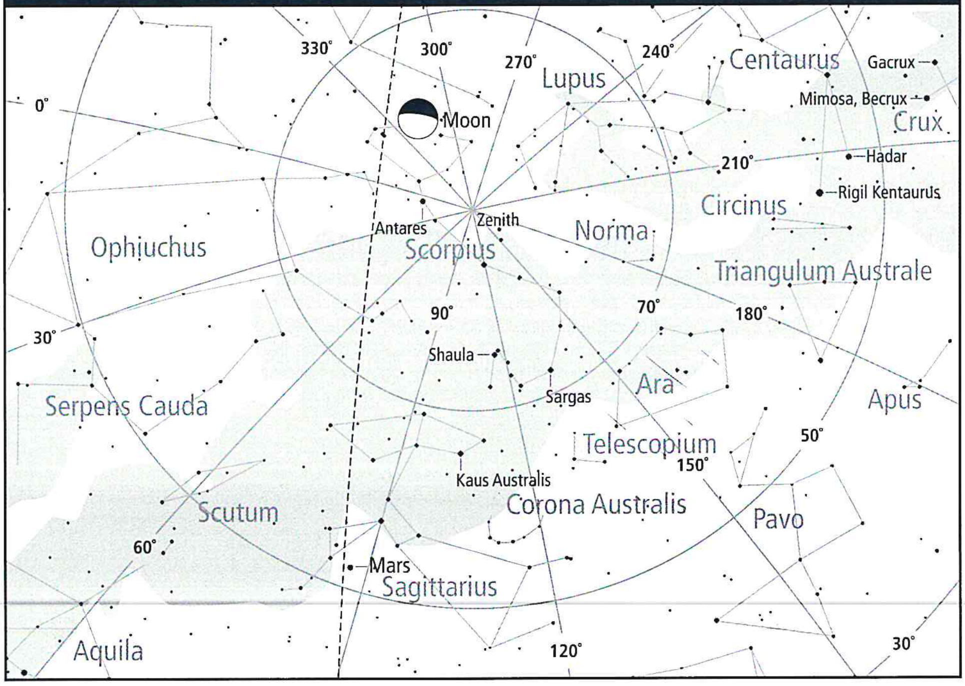
DAY	PHENOMENON			DAY	PHENOMENON			DAY	PHENOMENON			DAY	PHENOMENON		
	h m	Sat.	Event		h m	Sat.	Event		h m	Sat.	Event		h m	Sat.	Event
1	0015		GRS	8	2051		GRS	15	2136		GRS	24	0407		GRS
2	0602		GRS	8	2104	I	Tr.E.	15	2223	I	Sh.E.	24	1858	I	Tr.E.
3	0050	II	Sh.I.	10	0238		GRS	15	2249	I	Tr.E.	24	2359		GRS
3	0153		GRS	10	0325	II	Sh.I.	16	1956	I	Oc.R.	25	1950		GRS
3	0219	II	Tr.I.	10	0437	II	Tr.I.	17	0323		GRS	26	0343	II	Ec.D.
3	0332	II	Sh.E.	10	0607	II	Sh.E.	17	0601	II	Sh.I.	26	0545		GRS
3	0455	II	Tr.E.	10	2229		GRS	17	2314		GRS	27	0136		GRS
3	2144		GRS	11	0456	III	Ec.D.	19	0109	II	Ec.D.	27	2148		GRS
4	0058	III	Ec.D.	11	2235	II	Ec.D.	19	0432	II	Oc.R.	27	2154	II	Sh.I.
4	0341	III	Ec.R.	12	0217	II	Oc.R.	19	0500		GRS	27	2217	II	Tr.I.
4	0401	III	Oc.D.	12	0416		GRS	20	0052		GRS	28	0036	II	Sh.E.
5	0000	II	Oc.R.	13	0007		GRS	20	0615	I	Ec.D.	28	0054	II	Tr.E.
5	0331		GRS	13	0422	I	Ec.D.	20	1918	II	Sh.I.	28	0530	I	Sh.I.
5	0520	I	Sh.I.	13	2022	II	Tr.E.	20	2001	II	Tr.I.	28	0540	I	Tr.I.
5	0601	I	Tr.I.	14	0142	I	Sh.I.	20	2043		GRS	29	0238	I	Ec.D.
5	2322		GRS	14	0212	I	Tr.I.	20	2200	II	Sh.E.	29	0246	III	Sh.I.
6	0228	I	Ec.D.	14	0354	I	Sh.E.	20	2238	II	Tr.E.	29	0314		GRS
6	0519	I	Oc.R.	14	0422	I	Tr.E.	21	0336	I	Sh.I.	29	0330	III	Tr.I.
6	2349	I	Sh.I.	14	0553		GRS	21	0356	I	Tr.I.	29	0458	I	Oc.R.
7	0028	I	Tr.I.	14	2057	III	Tr.I.	21	0548	I	Sh.E.	29	0523	III	Sh.E.
7	0201	I	Sh.E.	14	2129	III	Sh.E.	21	0606	I	Tr.E.	29	0545	III	Tr.E.
7	0238	I	Tr.E.	14	2250	I	Ec.D.	21	0638		GRS	29	1954	II	Oc.R.
7	0509		GRS	14	2309	III	Tr.E.	21	2247	III	Sh.I.	29	2306		GRS
7	2056	I	Ec.D.	15	0130	I	Oc.R.	22	0014	III	Tr.I.	29	2358	I	Sh.I.
7	2345	I	Oc.R.	15	0145		GRS	22	0044	I	Ec.D.	30	0006	I	Tr.I.
8	0100		GRS	15	2011	I	Sh.I.	22	0126	III	Sh.E.	30	0210	I	Sh.E.
8	2029	I	Sh.E.	15	2038	I	Tr.I.	22	0227	III	Tr.E.	30	0216	I	Tr.E.
								22	0229		GRS	30	1857		GRS
								22	0314	I	Oc.R.	30	2106	I	Ec.D.
								22	2221		GRS	30	2324	I	Oc.R.
								22	2204	I	Sh.I.	31	0452		GRS
								22	2222	I	Tr.I.	31	1826	I	Sh.I.
								23	0016	I	Sh.E.	31	1832	I	Tr.I.
								23	0032	I	Tr.E.	31	2038	I	Sh.E.
								23	1912	I	Ec.D.	31	2042	I	Tr.E.
								23	2140	I	Oc.R.				

Moons: I Io; II Europa; III Ganymede; IV Callisto

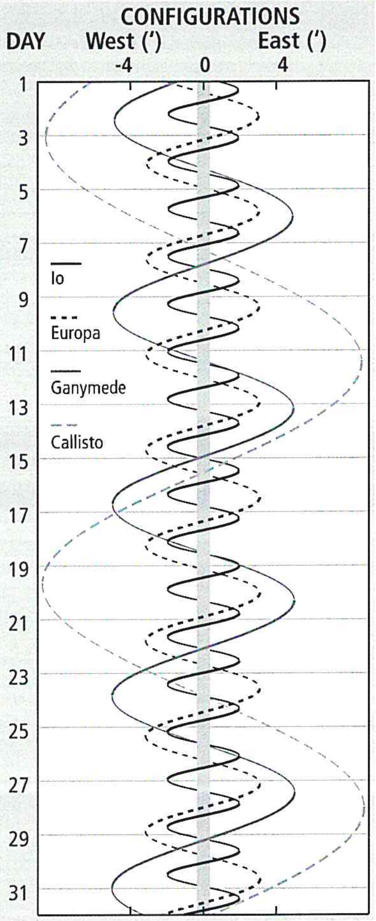
Events:
D Disappear
E Egress
Ec Eclipse
Sh Shadow
R Reappear
I Ingress
Oc Occult
Tr Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

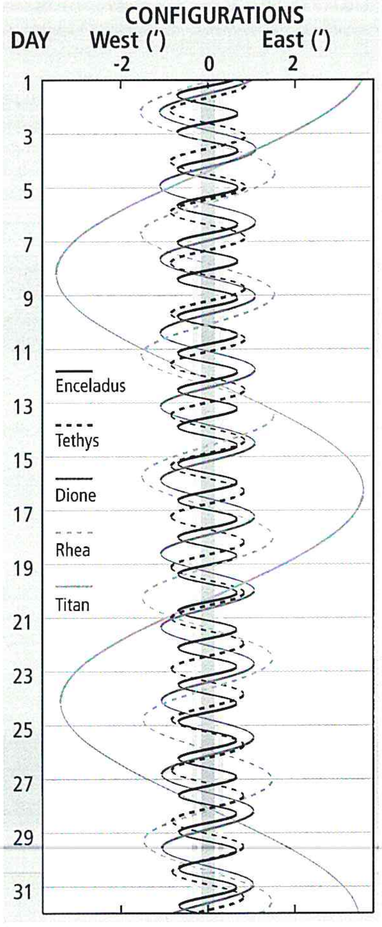
SKYVIEW 2005 MARCH 3 6am



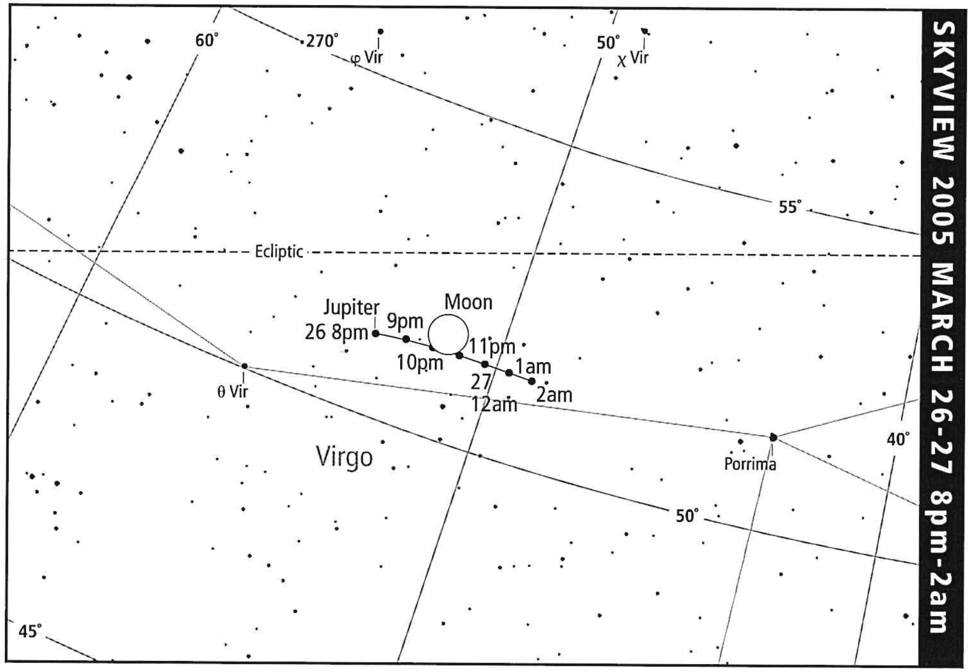
JUPITER MOONS



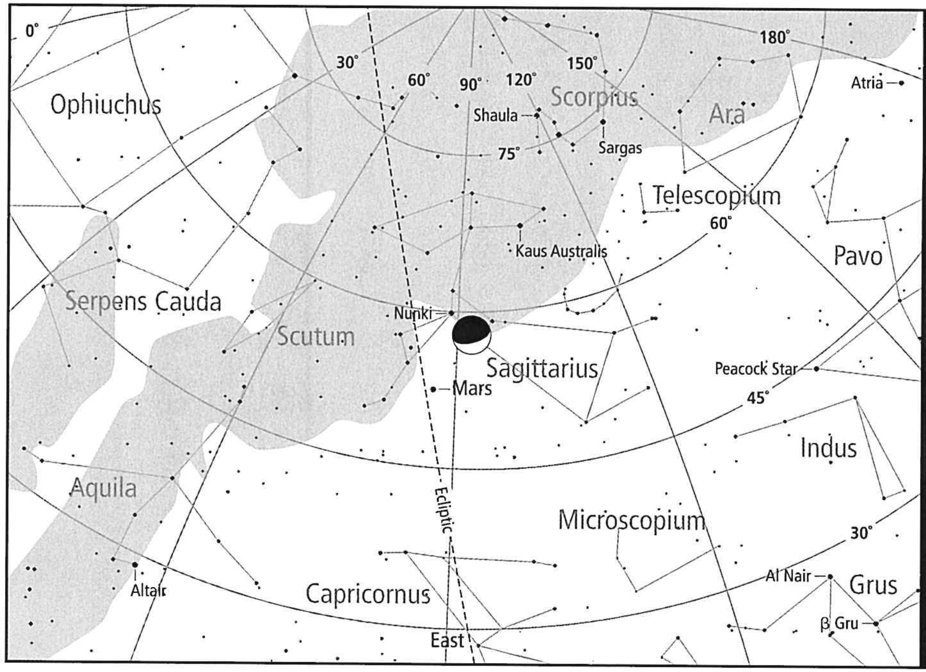
SATURN MOONS



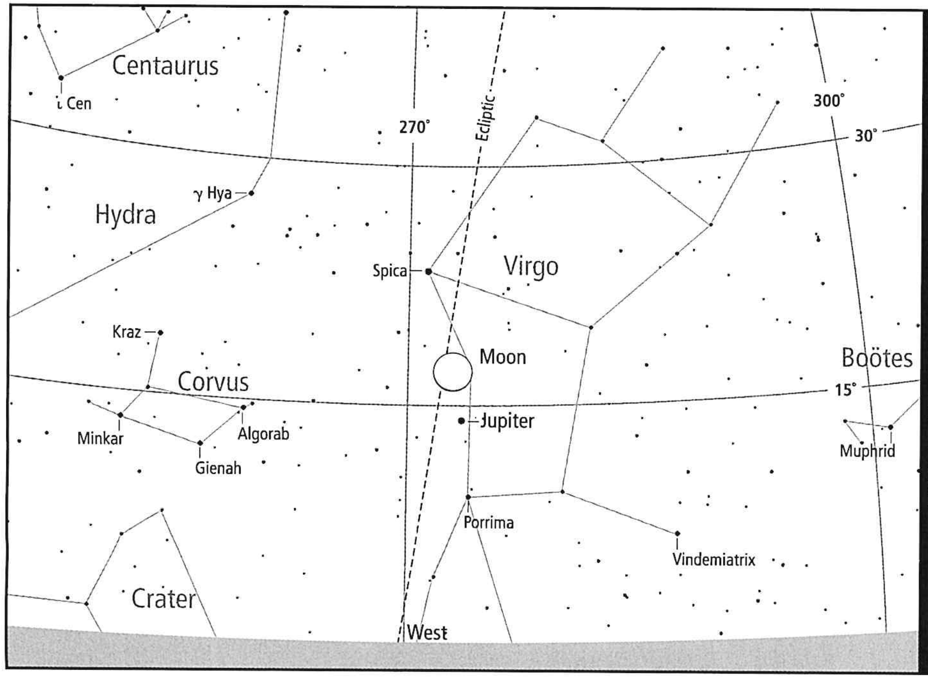
SKYVIEW 2005 MARCH 26-27 8pm-2am



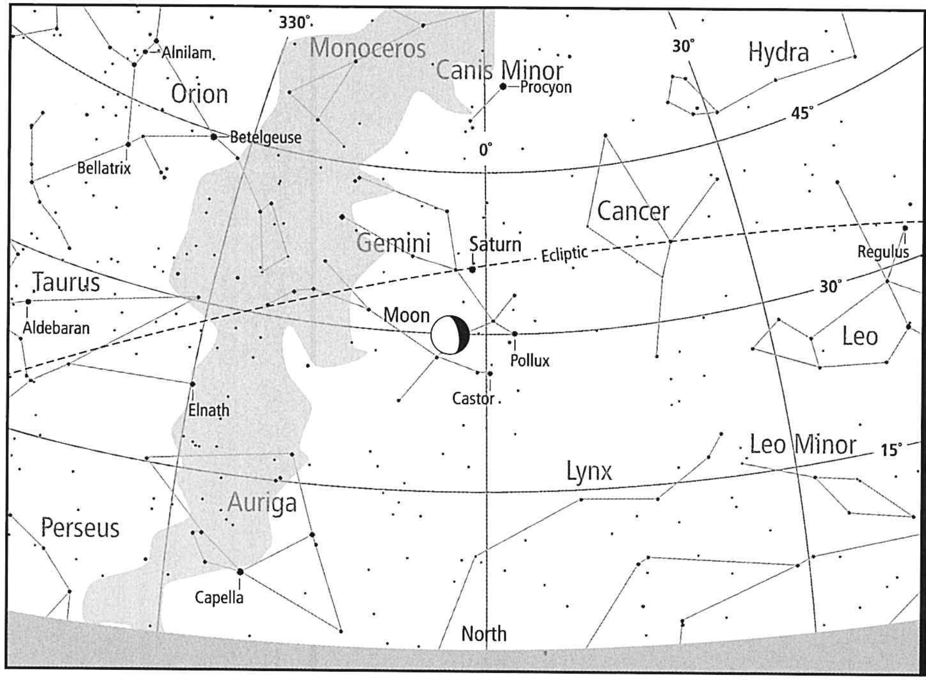
SKYVIEW 2005 MARCH 6 6am



SKYVIEW 2005 MARCH 27 6am



SKYVIEW 2005 MARCH 19 8pm



APRIL 2005

HIGHLIGHTS

Moon *penumbral eclipse on the 24th.*

Mercury *visible in the mornings in the second half of the month, low in the east before civil twilight.*

Mars *visible in the eastern morning sky.*

Jupiter *at opposition and visible all night in constellation Virgo.*

Saturn *visible in the evening in constellation Gemini.*

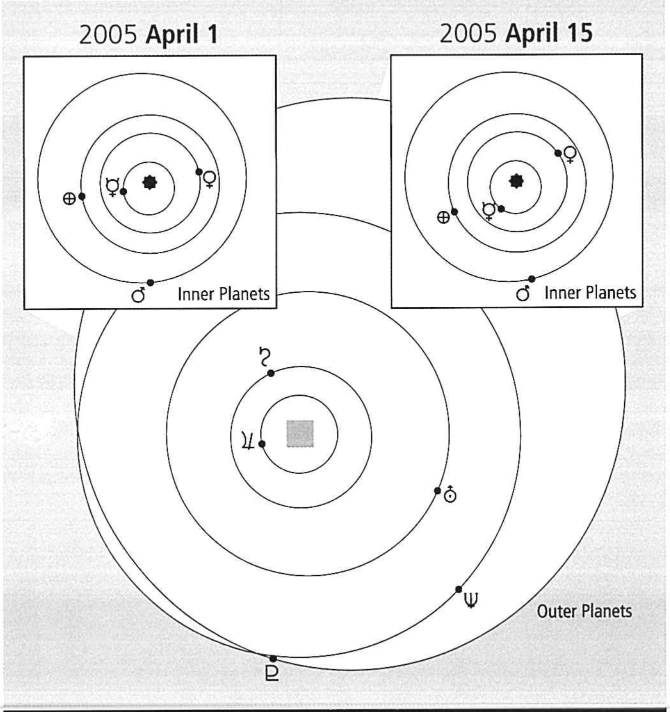
DIARY

Day	Hour	
2	09	**Last Quarter**
4	00	Jupiter at opposition
4	06	Mars 4° N. of Moon
4	19	Moon at perigee
7	22	Mercury 3° N. of Moon
9	05	**New Moon**
11	10	Mercury stationary
16	09	Saturn 5° S. of Moon
16	23	**First Quarter**
17	03	Moon at apogee
23	02	Jupiter 0.°6 N. of Moon
24	18	**Full Moon – Penumbral Eclipse of the Moon**
27	01	Mercury greatest elongation W. (27°)
27	07	Antares 0.°7 S. of Moon
29	18	Moon at perigee

SUN+MOON RISE/SET

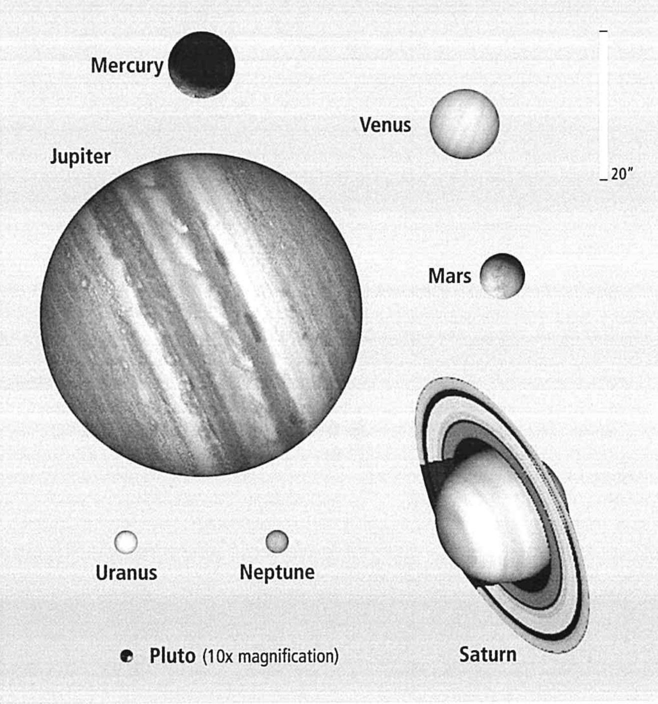
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0628	85	0507	1221	1813	275	1934	2248	1259	62
2	0629	85	0507	1220	1811	275	1932	2355	1359	51
3	0629	84	0508	1220	1810	276	1931	DNR	1451	39
4	0630	84	0509	1220	1809	276	1930	0105	1536	28
5	0631	83	0509	1219	1808	277	1929	0217	1614	18
6	0631	83	0510	1219	1806	277	1928	0326	1647	10
7	0632	83	0511	1219	1805	278	1926	0433	1718	4
8	0633	82	0511	1218	1804	278	1925	0539	1747	1
9	0633	82	0512	1218	1803	279	1924	0643	1817	0
10	0634	81	0513	1218	1802	279	1923	0747	1849	2
11	0635	81	0513	1218	1800	279	1922	0851	1924	5
12	0635	80	0514	1217	1759	280	1920	0954	2003	11
13	0636	80	0515	1217	1758	280	1919	1056	2047	18
14	0637	79	0515	1217	1757	281	1918	1154	2136	26
15	0637	79	0516	1217	1756	281	1917	1246	2230	35
16	0638	79	0516	1216	1755	282	1916	1332	2327	44
17	0639	78	0517	1216	1753	282	1915	1412	DNS	54
18	0639	78	0518	1216	1752	282	1914	1447	0025	63
19	0640	77	0518	1216	1751	283	1913	1518	0123	72
20	0641	77	0519	1216	1750	283	1912	1546	0221	80
21	0641	77	0519	1215	1749	284	1911	1613	0319	88
22	0642	76	0520	1215	1748	284	1910	1640	0417	94
23	0643	76	0521	1215	1747	284	1909	1708	0516	98
24	0643	75	0521	1215	1746	285	1908	1738	0618	100
25	0644	75	0522	1215	1745	285	1907	1813	0723	100
26	0645	75	0522	1214	1744	286	1906	1854	0832	97
27	0645	74	0523	1214	1743	286	1905	1943	0942	92
28	0646	74	0524	1214	1742	286	1904	2041	1051	84
29	0647	73	0524	1214	1741	287	1903	2147	1154	75
30	0647	73	0525	1214	1740	287	1903	2257	1249	65

PLANET POSITIONS



☿ Mercury	⊕ Earth	♃ Jupiter	⛢ Uranus	♇ Pluto
♀ Venus	♂ Mars	♄ Saturn	♆ Neptune	

PLANET APPEARANCE

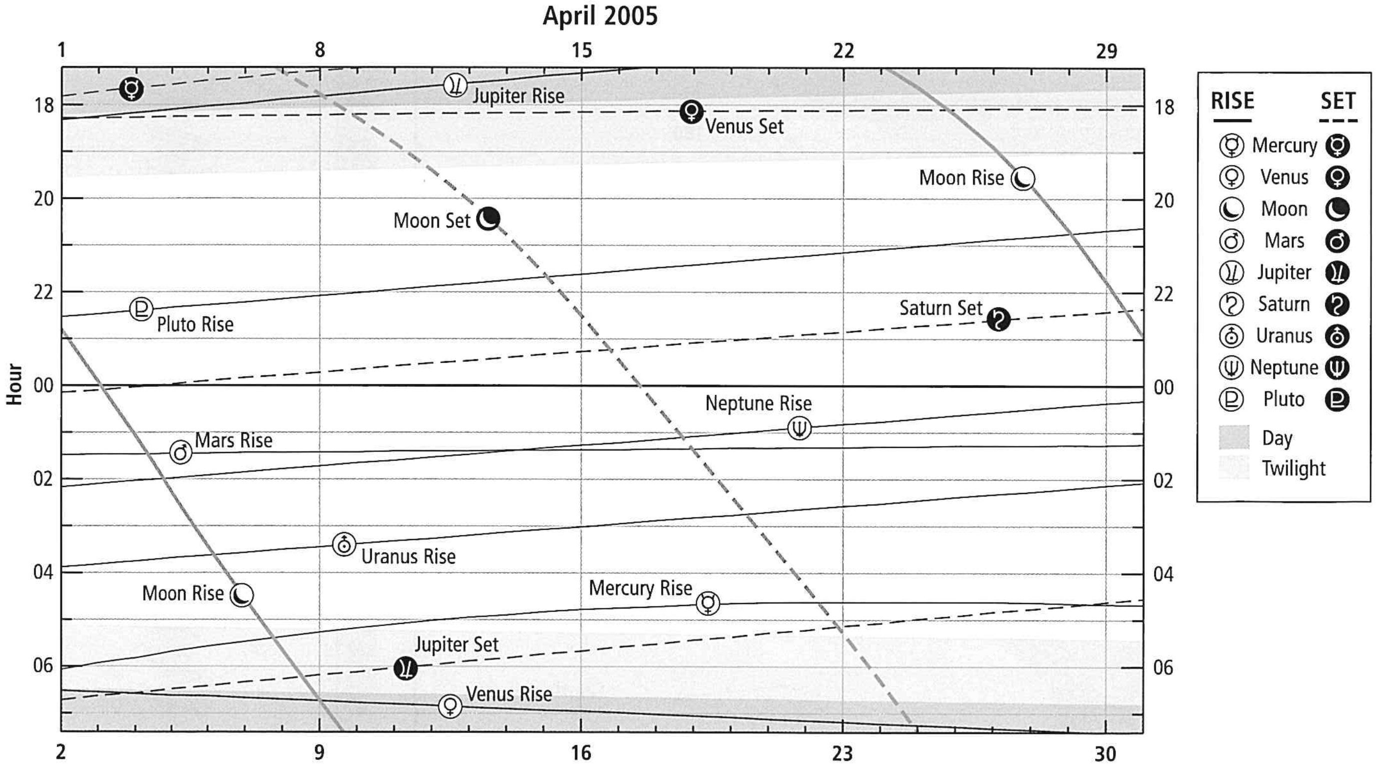


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0612	1749	0629	1817	0129	1515	1819	0647	1	1402	0013	0356	1645	0214	1539	2232	1157
2	0604	1743	0631	1817	0129	1514	1815	0643	2	1358	0009	0353	1641	0210	1535	2228	1153
3	0556	1738	0633	1816	0128	1512	1810	0638	3	1354	0006	0349	1637	0206	1531	2224	1149
4	0549	1734	0635	1815	0128	1511	1806	0634	4	1350	0002	0345	1634	0202	1527	2220	1145
4									4		2358						
5	0541	1729	0637	1815	0127	1509	1802	0629	5	1347	2354	0341	1630	0159	1524	2217	1141
6	0534	1725	0638	1814	0127	1508	1758	0625	6	1343	2350	0338	1626	0155	1520	2213	1137
7	0528	1720	0640	1814	0126	1506	1753	0620	7	1339	2347	0334	1622	0151	1516	2209	1133
8	0522	1716	0642	1813	0126	1505	1749	0616	8	1335	2343	0330	1619	0147	1512	2205	1129
9	0516	1713	0644	1812	0125	1503	1745	0611	9	1331	2339	0327	1615	0143	1508	2201	1126
10	0511	1709	0646	1812	0125	1501	1740	0607	10	1328	2335	0323	1611	0139	1504	2157	1122
11	0506	1706	0648	1811	0124	1500	1736	0602	11	1324	2331	0319	1607	0136	1500	2153	1118
12	0501	1703	0650	1811	0124	1458	1732	0558	12	1320	2328	0316	1603	0132	1457	2149	1114
13	0457	1700	0652	1810	0124	1457	1728	0553	13	1316	2324	0312	1600	0128	1453	2145	1110
14	0454	1657	0654	1810	0123	1455	1723	0549	14	1312	2320	0308	1556	0124	1449	2141	1106
15	0450	1655	0656	1809	0123	1454	1719	0544	15	1309	2316	0304	1552	0120	1445	2137	1102
16	0447	1652	0657	1809	0122	1452	1715	0540	16	1305	2313	0301	1548	0116	1441	2133	1058
17	0445	1650	0659	1808	0122	1450	1711	0535	17	1301	2309	0257	1544	0113	1437	2129	1054
18	0443	1648	0701	1808	0121	1449	1706	0531	18	1257	2305	0253	1540	0109	1433	2125	1050
19	0441	1646	0703	1808	0121	1447	1702	0526	19	1254	2302	0249	1537	0105	1429	2121	1046
20	0439	1645	0705	1807	0120	1445	1658	0522	20	1250	2258	0246	1533	0101	1426	2117	1042
21	0438	1643	0707	1807	0120	1444	1654	0517	21	1246	2254	0242	1529	0057	1422	2113	1038
22	0437	1641	0709	1807	0119	1442	1649	0513	22	1242	2251	0238	1525	0053	1418	2109	1034
23	0437	1640	0711	1806	0119	1440	1645	0508	23	1239	2247	0234	1521	0049	1414	2105	1030
24	0437	1639	0713	1806	0118	1439	1641	0504	24	1235	2243	0231	1518	0046	1410	2101	1026
25	0437	1638	0715	1806	0118	1437	1637	0459	25	1231	2240	0227	1514	0042	1406	2057	1022
26	0437	1636	0717	1805	0117	1435	1632	0455	26	1228	2236	0223	1510	0038	1402	2053	1018
27	0437	1635	0719	1805	0117	1433	1628	0450	27	1224	2232	0219	1506	0034	1358	2049	1014
28	0438	1635	0721	1805	0117	1432	1624	0446	28	1220	2229	0216	1502	0030	1354	2045	1010
29	0439	1634	0723	1805	0116	1430	1620	0442	29	1217	2225	0212	1458	0026	1351	2041	1006
30	0440	1633	0725	1805	0116	1428	1615	0437	30	1213	2221	0208	1455	0022	1347	2037	1002

SOLAR SYSTEM RISE/SET



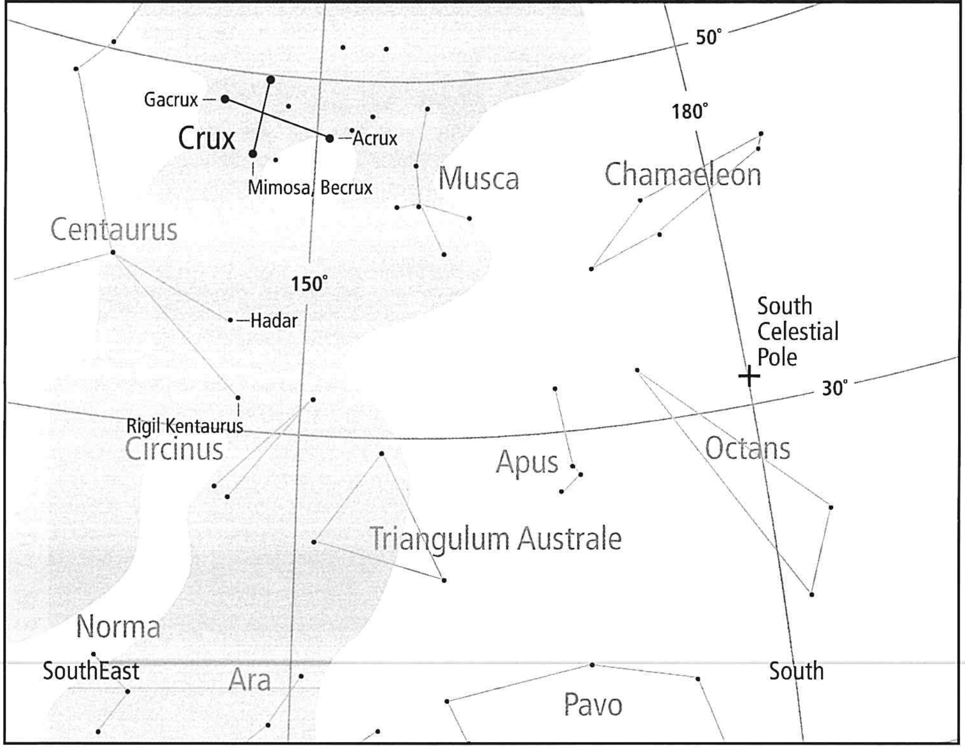
JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Sat.	Event
1	0043		GRS
1	1932	III	Oc.R.
1	2035		GRS
2	0618	II	Ec.D.
2	0630		GRS
3	0221		GRS
3	2213		GRS
4	0030	II	Sh.I.
4	0032	II	Tr.I.
4	0309	II	Tr.E.
4	0311	II	Sh.E.
5	0359		GRS
5	0431	I	Oc.D.
5	1931	II	Oc.D.
5	2215	II	Ec.R.
5	2351		GRS
6	0149	I	Tr.I.
6	0152	I	Sh.I.
6	0400	I	Tr.E.
6	0404	I	Sh.E.
6	1942		GRS
6	2257	I	Oc.D.
7	0113	I	Ec.R.
7	0537		GRS
7	2015	I	Tr.I.
7	2020	I	Sh.I.
7	2226	I	Tr.E.
7	2232	I	Sh.E.
8	0128		GRS
8	1942	I	Ec.R.
8	2030	III	Oc.D.
8	2120		GRS
8	2327	III	Ec.R.
10	0306		GRS
10	2258		GRS
11	0247	II	Tr.I.
11	0306	II	Sh.I.
11	0524	II	Tr.E.
11	0547	II	Sh.E.
11	1849		GRS
12	0444		GRS
12	2145	II	Oc.D.
13	0036		GRS
13	0049	II	Ec.R.
13	0333	I	Tr.I.
13	0346	I	Sh.I.
13	0544	I	Tr.E.
13	2037		GRS
14	0041	I	Oc.D.
14	0307	I	Ec.R.
14	1832	II	Tr.E.
14	1905	II	Sh.E.
14	2159	I	Tr.I.
14	2214	I	Sh.I.
15	0010	I	Tr.E.
15	0026	I	Sh.E.
15	0214		GRS
15	1907	I	Oc.D.
15	2136	I	Ec.R.
15	2205		GRS
15	2345	III	Oc.D.
16	0325	III	Ec.R.
16	1836	I	Tr.E.
16	1854	I	Sh.E.
17	0352		GRS
17	2343		GRS
18	0502	II	Tr.I.
18	1934		GRS
19	0530		GRS
19	2359	II	Oc.D.
20	0121		GRS
20	0323	II	Ec.R.
20	0517	I	Tr.I.
20	2112		GRS
21	0225	I	Oc.D.
21	0502	I	Ec.R.
21	1810	II	Tr.I.
21	1900	II	Sh.I.
21	2049	II	Tr.E.
21	2142	II	Sh.E.
21	2343	I	Tr.I.
22	0008	I	Sh.I.
22	0154	I	Tr.E.
22	0220	I	Sh.E.
22	0259		GRS
22	2052	I	Oc.D.
22	2250		GRS
22	2331	I	Ec.R.
23	0303	III	Oc.D.
23	1809	I	Tr.I.
23	1837	I	Sh.I.
23	1841		GRS
23	2020	I	Tr.E.
23	2048	I	Sh.E.
24	0437		GRS
24	1759	I	Ec.R.
25	0048		GRS
25	2020		GRS
26	1840	III	Sh.I.
26	1902	III	Tr.E.
26	2114	III	Sh.E.
27	0206		GRS
27	0215	II	Oc.D.
27	2158		GRS
28	0410	I	Oc.D.
28	2027	II	Tr.I.
28	2137	II	Sh.I.
28	2307	II	Tr.E.
29	0018	II	Sh.E.
29	0128	I	Tr.I.
29	0202	I	Sh.I.
29	0339	I	Tr.E.
29	0345		GRS
29	0414	I	Sh.E.
29	2237	I	Oc.D.
29	2336		GRS
30	0125	I	Ec.R.
30	1914	II	Ec.R.
30	1927		GRS
30	1955	I	Tr.I.
30	2031	I	Sh.I.
30	2206	I	Tr.E.
30	2243	I	Sh.E.

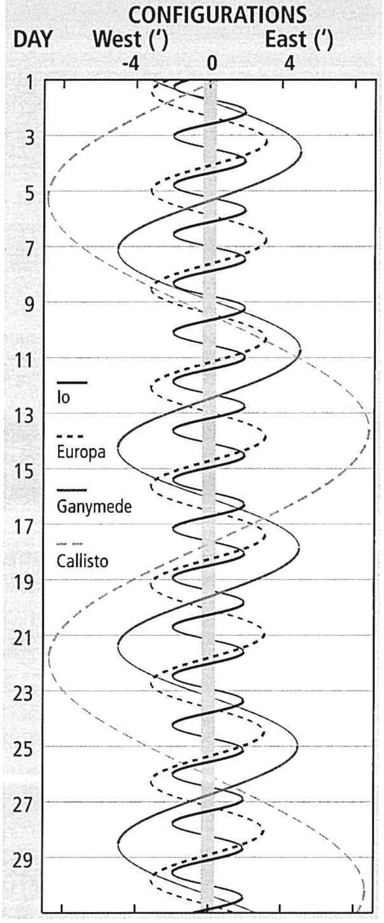
Moons: I Io, II Europa, III Ganymede, IV Callisto

Events:
D Disappear
E Egress
Ec Eclipse
Sh Shadow
R Reappear
I Ingress
Oc Occult
Tr Transit
GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

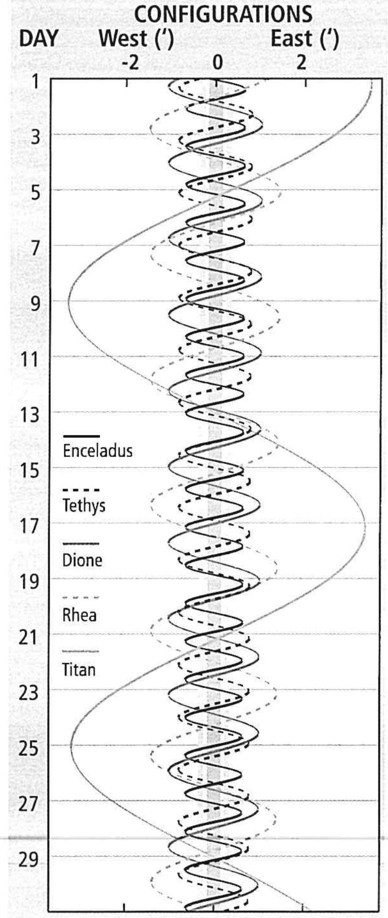
SKYVIEW APRIL 15 8pm – SOUTHERN CROSS

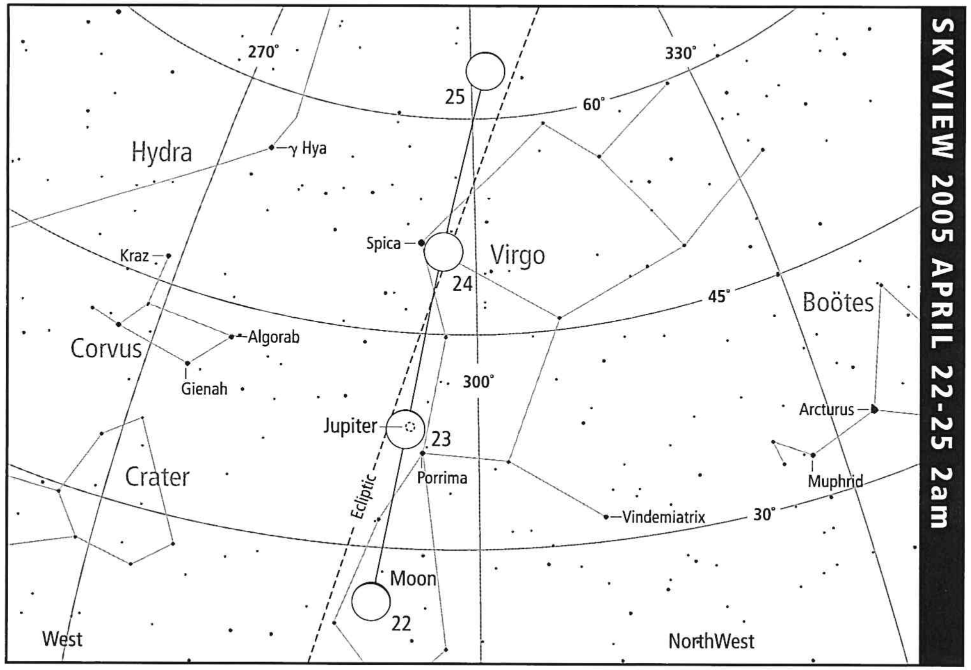


JUPITER MOONS

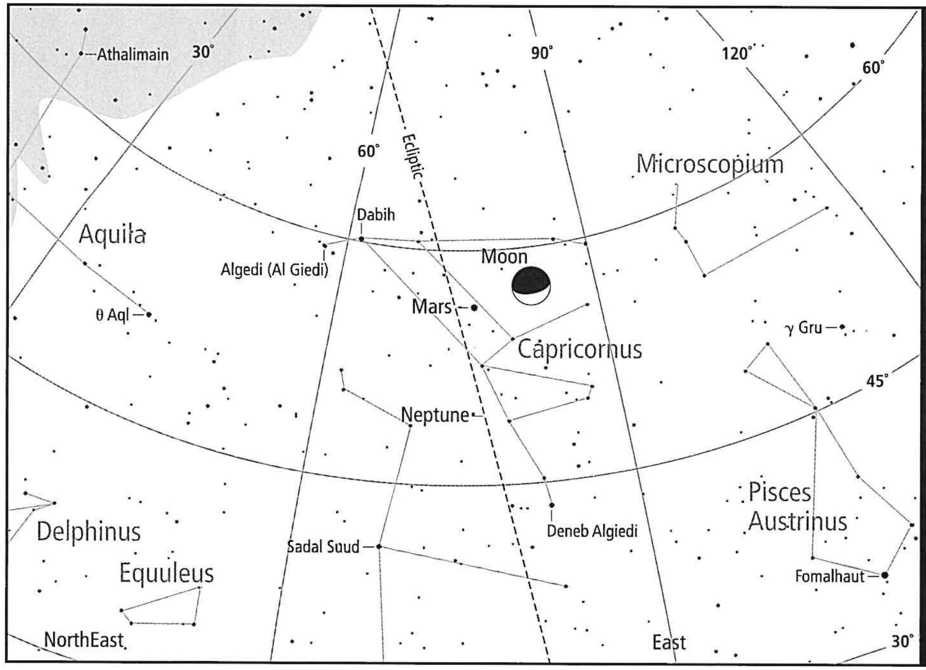


SATURN MOONS

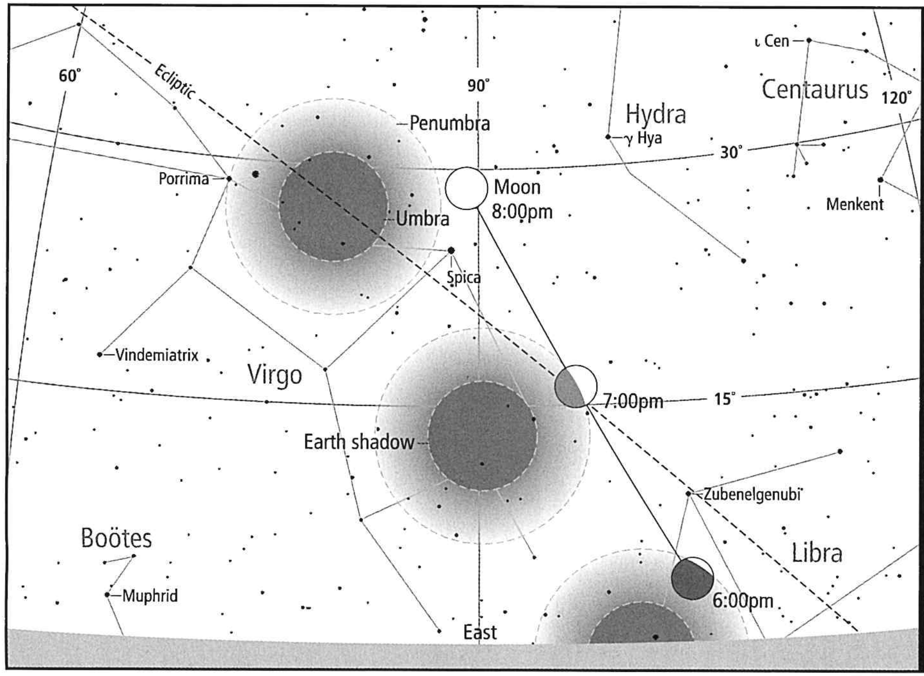




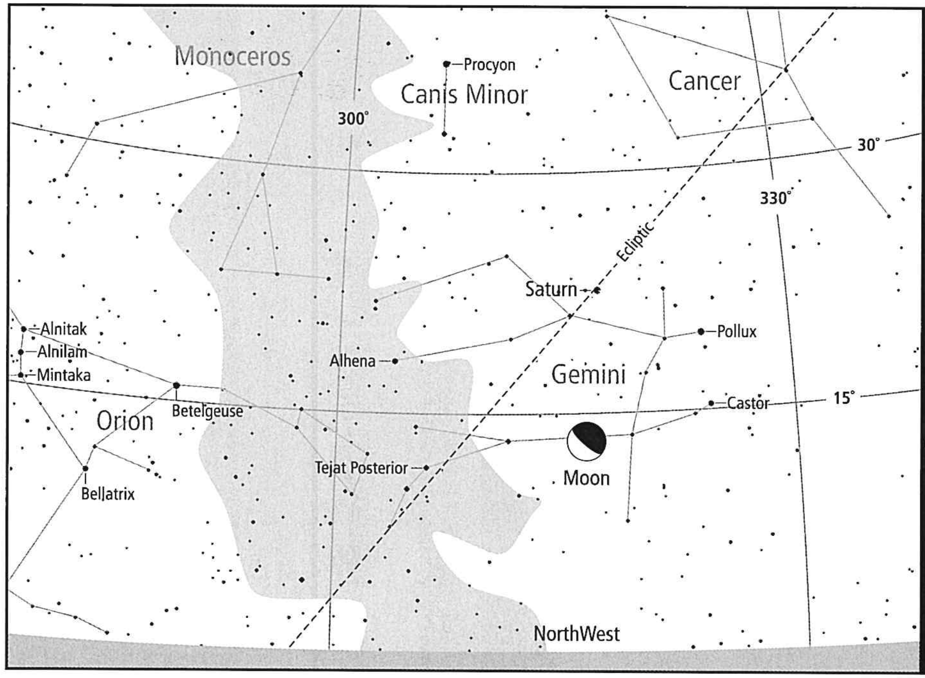
SKYVIEW 2005 APRIL 22-25 2am



SKYVIEW 2005 APRIL 4 6am



SKYVIEW 2005 APRIL 24 6-8pm



SKYVIEW 2005 APRIL 15 9pm

MAY 2005

HIGHLIGHTS

Mercury *visible in the morning, low in the east before civil twilight.*

Venus *visible in the early evening sky.*

Mars *visible in the morning sky in the constellation Aquarius.*

Jupiter *visible in the evening and sets well after midnight in constellation Virgo.*

Saturn *visible in the early evening northwest sky in constellation Gemini.*

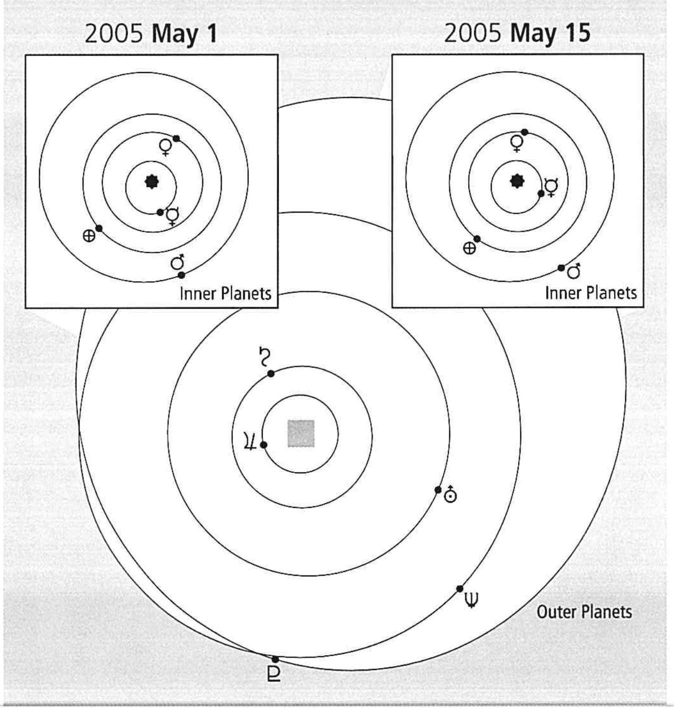
DIARY

Day	Hour	
1	14	**Last Quarter**
2	23	Mars 3° N. of Moon
4		Maximum activity of eta-Aquarid meteor shower
6	18	Mercury 3° S. of Moon
8	17	**New Moon**
13	21	Saturn 5° S. of Moon
14	22	Moon at apogee
16	17	**First Quarter**
19		Maximum activity of Sagittarid meteor shower
19	05	Venus 6° N. of Aldebaran
20	06	Jupiter 0.°4 N. of Moon
24	04	**Full Moon**
24	16	Antares 0.°8 S. of Moon
26	19	Moon at perigee
30	20	**Last Quarter**
31	13	Saturn 7° S. of Pollux
31	17	Mars 0.°5 N. of Moon

SUN+MOON RISE/SET

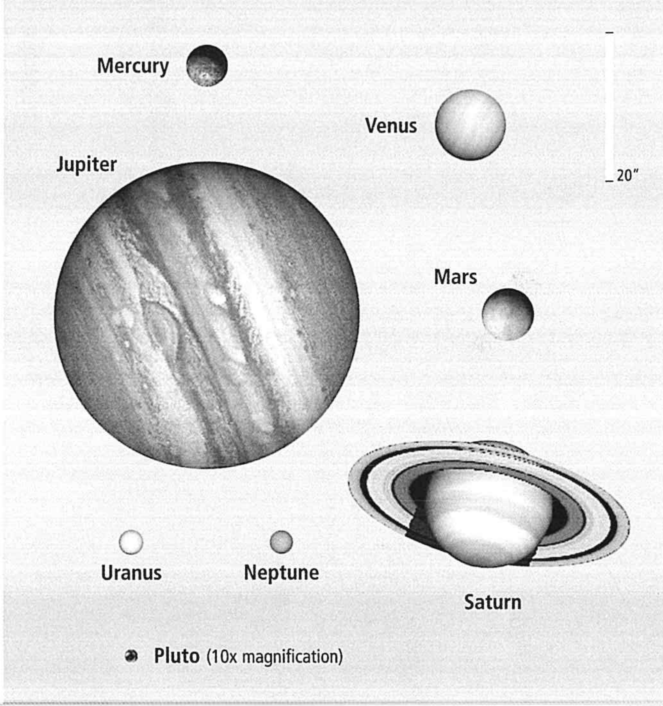
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0648	73	0525	1214	1739	287	1902	DNR	1336	53
2	0649	72	0526	1214	1738	288	1901	0007	1415	42
3	0650	72	0526	1213	1737	288	1900	0116	1449	31
4	0650	72	0527	1213	1736	288	1859	0223	1519	21
5	0651	71	0528	1213	1735	289	1859	0327	1548	13
6	0652	71	0528	1213	1734	289	1858	0430	1617	6
7	0652	71	0529	1213	1734	289	1857	0533	1647	2
8	0653	70	0529	1213	1733	290	1856	0636	1720	0
9	0654	70	0530	1213	1732	290	1856	0739	1757	1
10	0654	70	0530	1213	1731	290	1855	0842	1840	3
11	0655	69	0531	1213	1730	291	1855	0942	1927	7
12	0656	69	0532	1213	1730	291	1854	1037	2020	13
13	0656	69	0532	1213	1729	291	1853	1126	2116	20
14	0657	68	0533	1213	1728	292	1853	1209	2214	28
15	0658	68	0533	1213	1728	292	1852	1245	2312	37
16	0658	68	0534	1213	1727	292	1852	1317	DNS	47
17	0659	68	0534	1213	1726	292	1851	1346	0009	56
18	0700	67	0535	1213	1726	293	1851	1413	0106	66
19	0700	67	0535	1213	1725	293	1850	1439	0203	75
20	0701	67	0536	1213	1725	293	1850	1506	0301	83
21	0702	67	0536	1213	1724	294	1850	1535	0401	90
22	0702	66	0537	1213	1724	294	1849	1608	0505	96
23	0703	66	0538	1213	1723	294	1849	1647	0612	99
24	0704	66	0538	1213	1723	294	1848	1733	0723	100
25	0704	66	0539	1213	1722	294	1848	1829	0835	98
26	0705	65	0539	1214	1722	295	1848	1934	0943	94
27	0706	65	0540	1214	1722	295	1848	2045	1043	86
28	0706	65	0540	1214	1721	295	1847	2158	1133	77
29	0707	65	0541	1214	1721	295	1847	2309	1215	67
30	0707	65	0541	1214	1721	295	1847	DNR	1251	56
31	0708	65	0542	1214	1720	296	1847	0016	1322	44

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

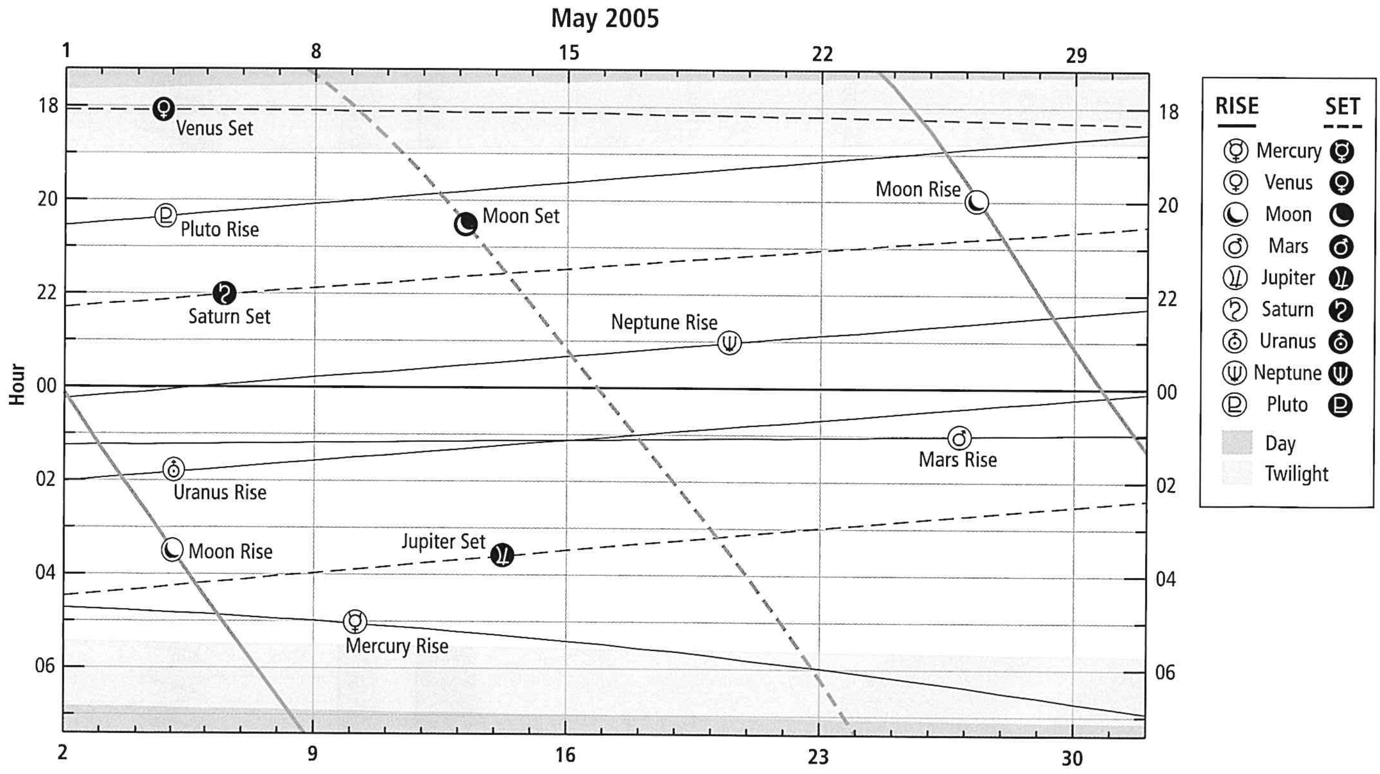


1 degree (1°) = 60 arc minutes (60') = 3600 arc seconds (3600")
Therefore 20" = 1/3' = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0441	1632	0727	1805	0115	1426	1611	0433	1	1209	2218	0204	1451	0019	1343	2033	0958
2	0443	1632	0729	1805	0115	1425	1607	0428	2	1206	2214	0201	1447	0015	1339	2029	0954
3	0445	1631	0731	1805	0114	1423	1603	0424	3	1202	2211	0157	1443	0011	1335	2025	0950
4	0447	1631	0733	1805	0114	1421	1559	0420	4	1158	2207	0153	1439	0007	1331	2021	0946
5	0449	1631	0735	1805	0113	1419	1554	0415	5	1155	2203	0149	1435	0003	1327	2017	0942
5									5					2359			
6	0451	1630	0737	1805	0113	1417	1550	0411	6	1151	2200	0146	1432	2355	1323	2013	0938
7	0454	1630	0739	1805	0112	1416	1546	0407	7	1147	2156	0142	1428	2351	1319	2009	0934
8	0457	1630	0741	1805	0112	1414	1542	0402	8	1144	2153	0138	1424	2347	1315	2005	0930
9	0459	1630	0743	1806	0111	1412	1538	0358	9	1140	2149	0134	1420	2343	1311	2001	0926
10	0503	1630	0745	1806	0111	1410	1534	0354	10	1136	2146	0130	1416	2340	1308	1957	0922
11	0506	1631	0747	1806	0110	1408	1530	0350	11	1133	2142	0127	1412	2336	1304	1953	0918
12	0509	1631	0749	1807	0109	1406	1525	0345	12	1129	2138	0123	1408	2332	1300	1949	0914
13	0513	1631	0751	1807	0109	1404	1521	0341	13	1126	2135	0119	1405	2328	1256	1945	0910
14	0517	1632	0753	1807	0108	1403	1517	0337	14	1122	2131	0115	1401	2324	1252	1941	0906
15	0521	1633	0755	1808	0108	1401	1513	0333	15	1118	2128	0111	1357	2320	1248	1937	0902
16	0525	1633	0757	1808	0107	1359	1509	0328	16	1115	2124	0108	1353	2316	1244	1933	0858
17	0529	1634	0759	1809	0107	1357	1505	0324	17	1111	2121	0104	1349	2312	1240	1929	0853
18	0534	1635	0801	1810	0106	1355	1501	0320	18	1108	2117	0100	1345	2308	1236	1925	0849
19	0538	1636	0803	1810	0106	1353	1457	0316	19	1104	2114	0056	1341	2304	1232	1921	0845
20	0543	1638	0805	1811	0105	1351	1453	0312	20	1100	2110	0052	1338	2300	1228	1917	0841
21	0549	1639	0807	1812	0104	1349	1448	0307	21	1057	2107	0048	1334	2256	1224	1913	0837
22	0554	1641	0809	1812	0104	1347	1444	0303	22	1053	2103	0045	1330	2252	1220	1909	0833
23	0559	1643	0811	1813	0103	1345	1440	0259	23	1050	2100	0041	1326	2249	1217	1905	0829
24	0605	1645	0812	1814	0103	1343	1436	0255	24	1046	2056	0037	1322	2245	1213	1901	0825
25	0611	1647	0814	1815	0102	1342	1432	0251	25	1042	2053	0033	1318	2241	1209	1857	0821
26	0617	1649	0816	1816	0102	1340	1428	0247	26	1039	2049	0029	1314	2237	1205	1853	0817
27	0623	1652	0818	1817	0101	1338	1424	0243	27	1035	2046	0025	1310	2233	1201	1849	0813
28	0630	1655	0820	1818	0100	1336	1420	0239	28	1032	2043	0021	1306	2229	1157	1845	0809
29	0636	1658	0821	1819	0100	1334	1416	0235	29	1028	2039	0018	1303	2225	1153	1841	0805
30	0643	1701	0823	1820	0059	1332	1412	0231	30	1025	2036	0014	1259	2221	1149	1837	0801
31	0649	1704	0825	1821	0058	1330	1408	0227	31	1021	2032	0010	1255	2217	1145	1833	0757

SOLAR SYSTEM RISE/SET



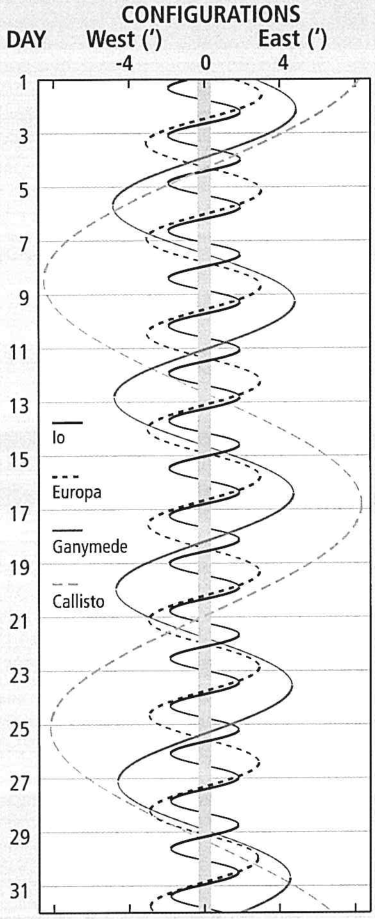
JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON		
	h m	Sat.	Event
1	1954	I	Ec.R.
2	0114		GRS
2	2105		GRS
3	1956	III	Tr.I.
3	2225	III	Tr.E.
3	2239	III	Sh.I.
4	0111	III	Sh.E.
4	0252		GRS
4	2244		GRS
5	1835		GRS
5	2246	II	Tr.I.
6	0014	II	Sh.I.
6	0126	II	Tr.E.
6	0255	II	Sh.E.
6	0314	I	Tr.I.
6	0357	I	Sh.I.
6	0430		GRS
7	0022		GRS
7	0023	I	Oc.D.
7	0320	I	Ec.R.
7	1740	II	Oc.D.
7	2013		GRS
7	2140	I	Tr.I.
7	2148	II	Ec.R.
7	2225	I	Sh.I.
7	2352	I	Tr.E.
8	0037	I	Sh.E.
8	1850	I	Oc.D.
8	2149	I	Ec.R.
9	0150		GRS
9	1818	I	Tr.E.
9	1905	I	Sh.E.
9	2151		GRS
10	2321	III	Tr.I.
11	0152	III	Tr.E.
11	0237	III	Sh.I.
11	0338		GRS
11	2330		GRS
12	1921		GRS
13	0107	II	Tr.I.
13	0251	II	Sh.I.
14	0108		GRS
14	0210	I	Oc.D.
14	1918	III	Ec.R.
14	2000	II	Oc.D.
14	2059		GRS
14	2327	I	Tr.I.
15	0020	I	Sh.I.
15	0023	II	Ec.R.
15	0139	I	Tr.E.
15	0231	I	Sh.E.
15	2037	I	Oc.D.
15	2344	I	Ec.R.
16	0246		GRS
16	1754	I	Tr.I.
16	1848	I	Sh.I.
16	1851	II	Sh.E.
16	2006	I	Tr.E.
16	2100	I	Sh.E.
16	2238		GRS
17	1812	I	Ec.R.
17	1829		GRS
18	0249	III	Tr.I.
19	0016		GRS
19	2007		GRS
21	0155		GRS
21	1920	III	Oc.R.
21	2046	III	Ec.D.
21	2146		GRS
21	2221	II	Oc.D.
21	2317	III	Ec.R.
22	0115	I	Tr.I.
22	0214	I	Sh.I.
22	0257	II	Ec.R.
22	2226	I	Oc.D.
23	0139	I	Ec.R.
23	1847	II	Sh.I.
23	1924	II	Tr.E.
23	1942	I	Tr.I.
23	2043	I	Sh.I.
23	2128	II	Sh.E.
23	2154	I	Tr.E.
23	2254	I	Sh.E.
23	2324		GRS
24	1916		GRS
24	2007	I	Ec.R.
26	0103		GRS
26	2054		GRS
28	0241		GRS
28	2019	III	Oc.D.
28	2233		GRS
28	2258	III	Oc.R.
29	0044	II	Oc.D.
29	0045	III	Ec.D.
29	1824		GRS
30	0015	I	Oc.D.
30	1909	II	Tr.I.
30	2124	II	Sh.I.
30	2132	I	Tr.I.
30	2151	II	Tr.E.
30	2237	I	Sh.I.
30	2343	I	Tr.E.
31	0005	II	Sh.E.
31	0011		GRS
31	0048	I	Sh.E.
31	1843	I	Oc.D.
31	2003		GRS
31	2202	I	Ec.R.

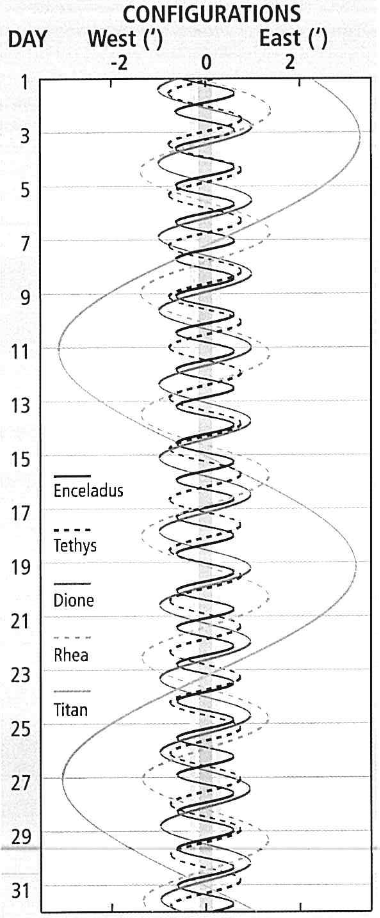
Moons:	**I**	**Io**	**III**	**Ganymede**
	II	**Europa**	**IV**	**Callisto**
Events:	**D**	**Disappear**	**R**	**Reappear**
	E	**Egress**	**I**	**Ingress**
	Ec	**Eclipse**	**Oc**	**Occult**
	Sh	**Shadow**	**Tr**	**Transit**

GRS **Jupiter's Great Red Spot** will be visible for approximately 1 hour around time shown

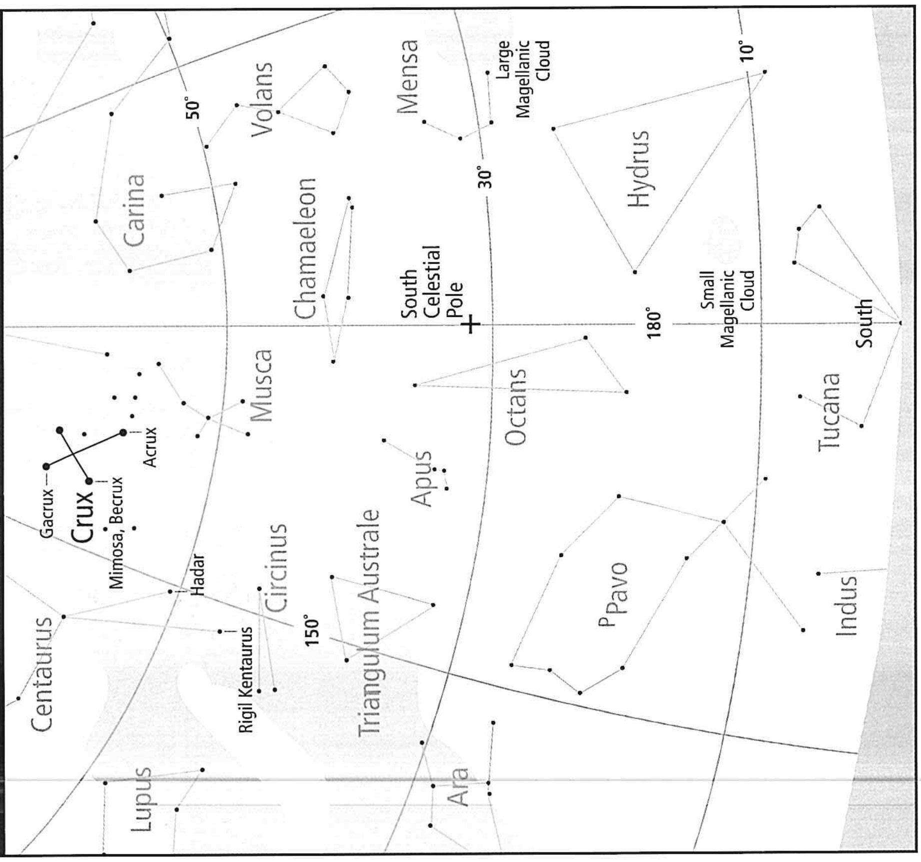
JUPITER MOONS

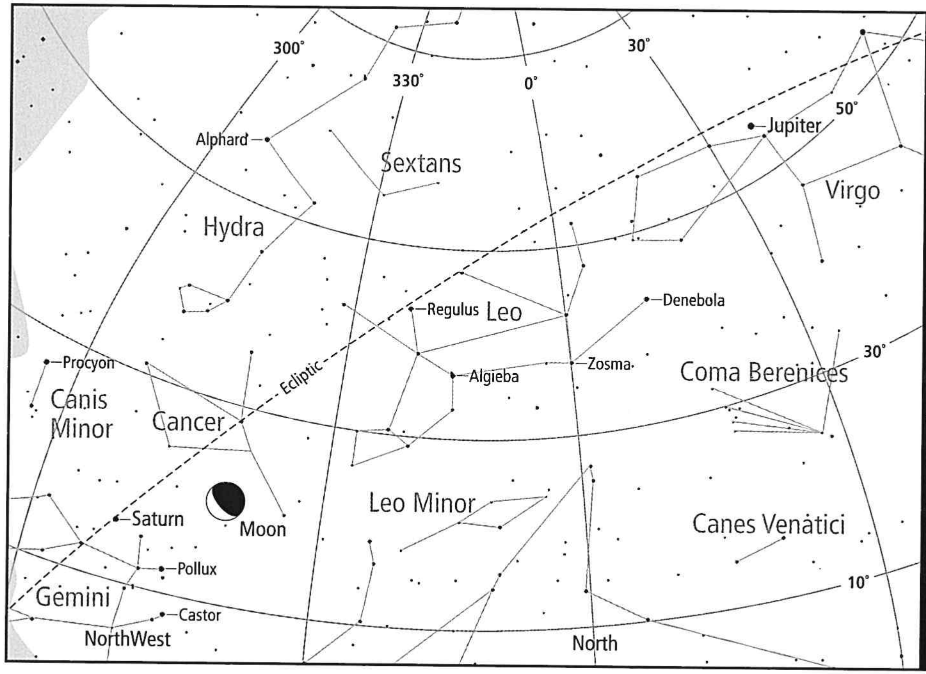


SATURN MOONS

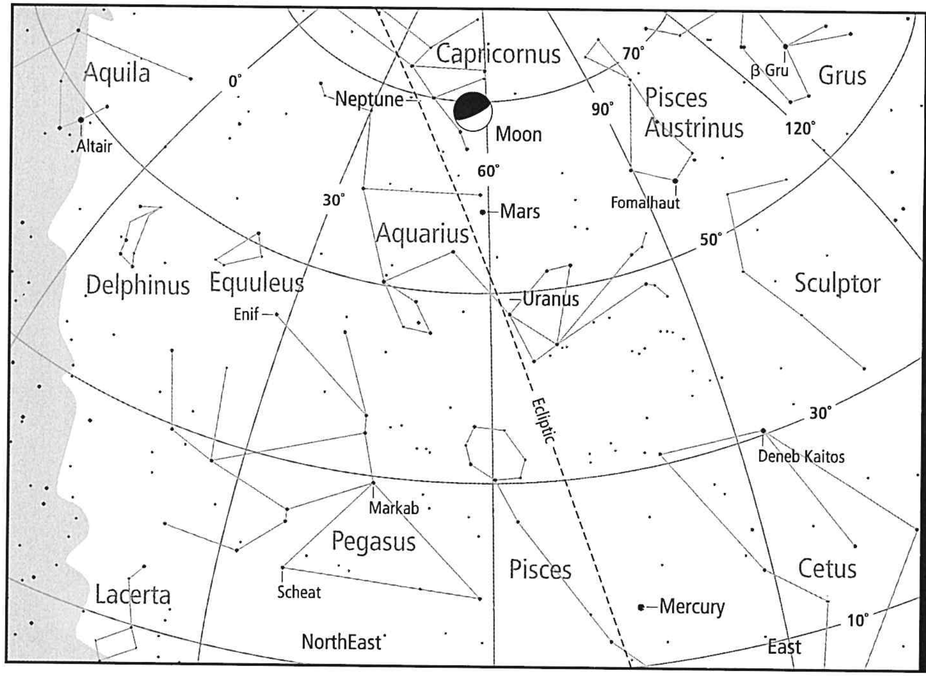


SKYVIEW MAY 15 8pm – SOUTHERN CROSS

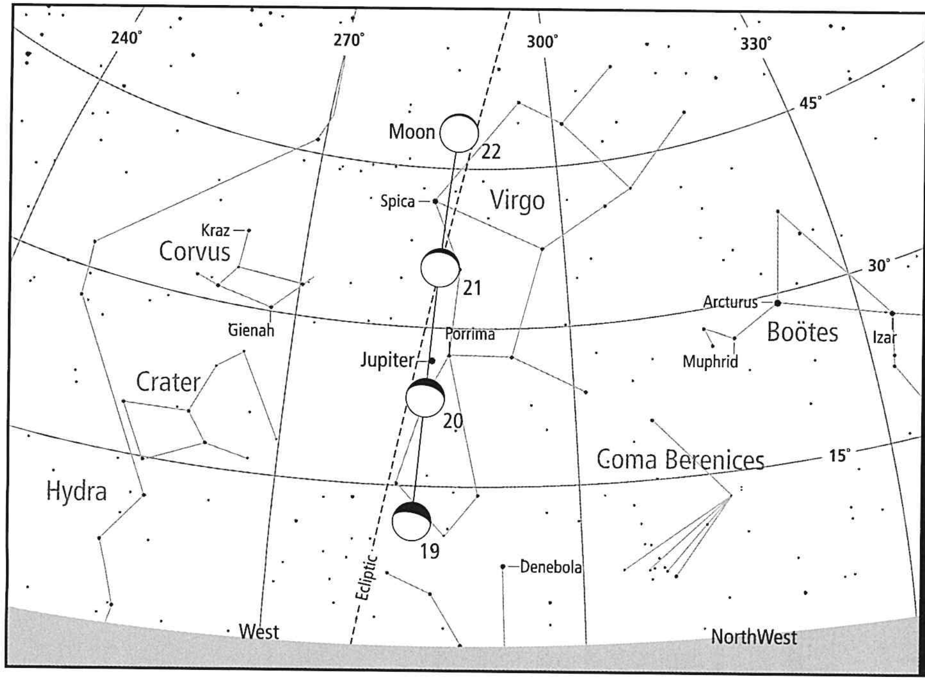




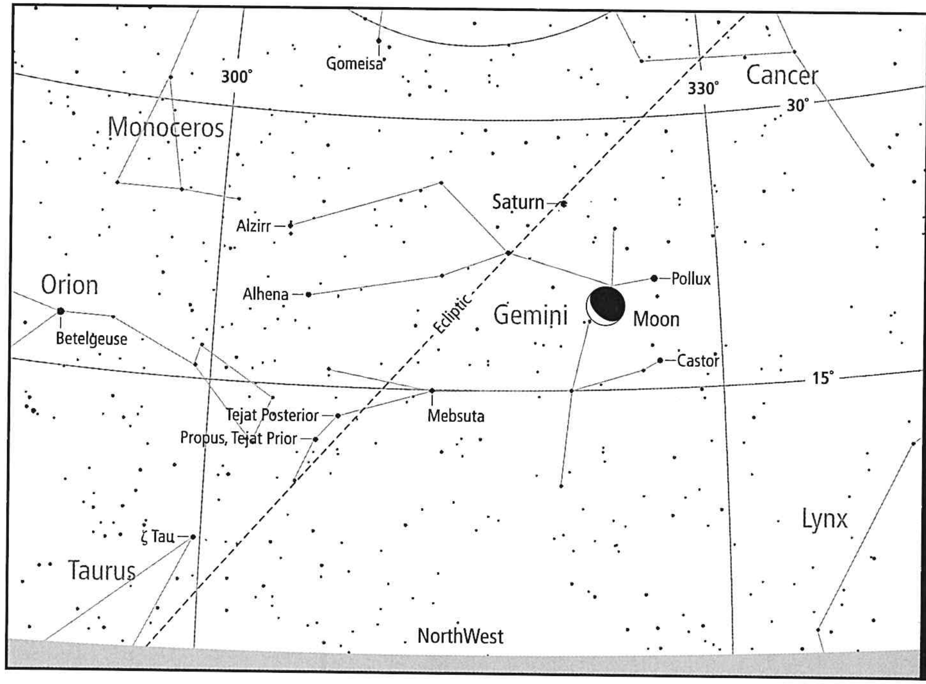
SKYVIEW 2005 MAY 14 8pm



SKYVIEW 2005 MAY 2 6am



SKYVIEW 2005 MAY 19-22 1am



SKYVIEW 2005 MAY 13 7pm

JUNE 2005

HIGHLIGHTS

Mercury *visible evenings from mid month, low in West-NW around end of civil twilight.*

Venus *easily visible in the western evening sky. Conjunction with Mercury on the 28th.*

Mars *visible in the morning sky in Pisces.*

Jupiter *visible in the evening. Occultation by Moon on 16th around 1500 visible from northern Australia. Around this time Jupiter may be visible to the unaided eye close to the Moon (**Do NOT look at the Sun**).*

SATURN *visible in the northwest sky early in the evening in Gemini. Conjunctions with Venus and Mercury on the 26th.*

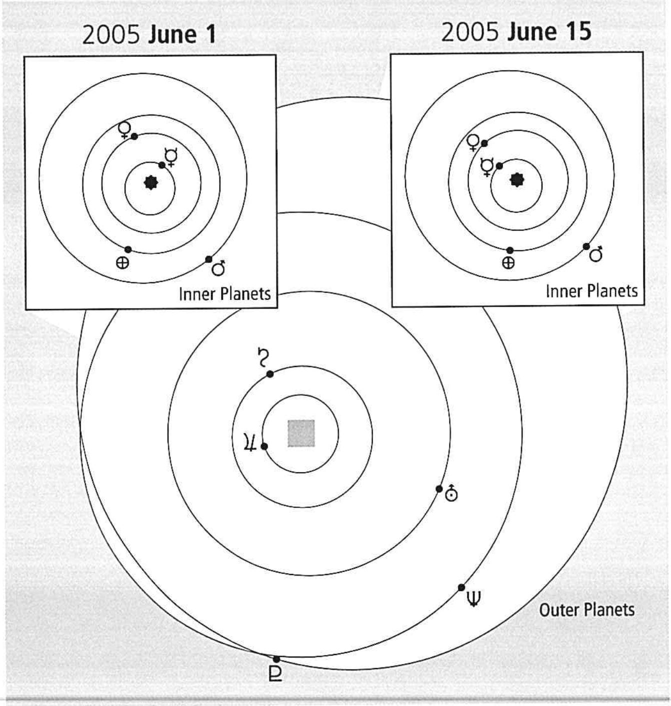
DIARY

Day	Hour	
3	17	Mercury in superior conjunction
6	06	Jupiter stationary
7	06	**New Moon**
8	20	Venus 4° S. of Moon
10	10	Saturn 5° S. of Moon
11	14	Moon at apogee
14	11	Pluto at opposition
15	09	**First Quarter**
16	15	Jupiter 0.°4 N. of Moon - Occultation
21	02	Antares 0.°7 S. of Moon
21	15	Solstice
22	12	**Full Moon**
23	20	Moon at perigee
23	20	Venus 5° S. of Pollux
24	16	Mercury 5° S. of Pollux
26	05	Venus 1.°3 N. of Saturn – Conjunction
26	14	Mercury 1.°4 N. of Saturn – Conjunction
28	05	Mercury 0.°08 S. of Venus – Conjunction
29	02	**Last Quarter**
29	12	Mars 2° S. of Moon

SUN+MOON RISE/SET

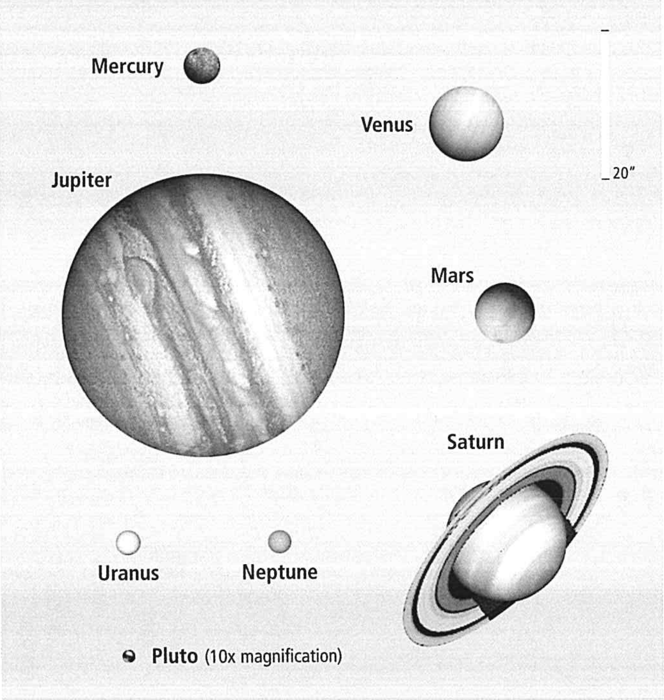
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0708	64	0542	1214	1720	296	1847	0120	1351	34
2	0709	64	0542	1215	1720	296	1846	0223	1420	24
3	0710	64	0543	1215	1720	296	1846	0325	1449	15
4	0710	64	0543	1215	1719	296	1846	0427	1521	9
5	0711	64	0544	1215	1719	296	1846	0529	1556	4
6	0711	64	0544	1215	1719	296	1846	0631	1636	1
7	0712	63	0545	1215	1719	297	1846	0732	1721	0
8	0712	63	0545	1216	1719	297	1846	0828	1812	1
9	0713	63	0545	1216	1719	297	1846	0920	1907	4
10	0713	63	0546	1216	1719	297	1846	1005	2004	9
11	0713	63	0546	1216	1719	297	1846	1043	2102	15
12	0714	63	0547	1216	1719	297	1846	1117	2159	22
13	0714	63	0547	1217	1719	297	1846	1147	2256	31
14	0715	63	0547	1217	1719	297	1846	1214	2352	40
15	0715	63	0548	1217	1719	297	1846	1240	DNS	50
16	0715	63	0548	1217	1719	297	1847	1306	0048	59
17	0716	63	0548	1217	1719	297	1847	1333	0146	69
18	0716	63	0548	1218	1719	297	1847	1403	0246	78
19	0716	63	0549	1218	1720	297	1847	1438	0351	87
20	0716	63	0549	1218	1720	297	1847	1521	0500	93
21	0717	63	0549	1218	1720	297	1847	1613	0612	98
22	0717	63	0549	1219	1720	297	1848	1715	0723	100
23	0717	63	0550	1219	1720	297	1848	1826	0828	99
24	0717	63	0550	1219	1721	297	1848	1940	0924	95
25	0717	63	0550	1219	1721	297	1848	2055	1011	88
26	0717	63	0550	1219	1721	297	1849	2205	1050	80
27	0718	63	0550	1220	1722	297	1849	2313	1124	70
28	0718	63	0550	1220	1722	297	1849	DNR	1154	59
29	0718	63	0550	1220	1722	297	1850	0017	1223	48
30	0718	63	0550	1220	1723	297	1850	0119	1252	37

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

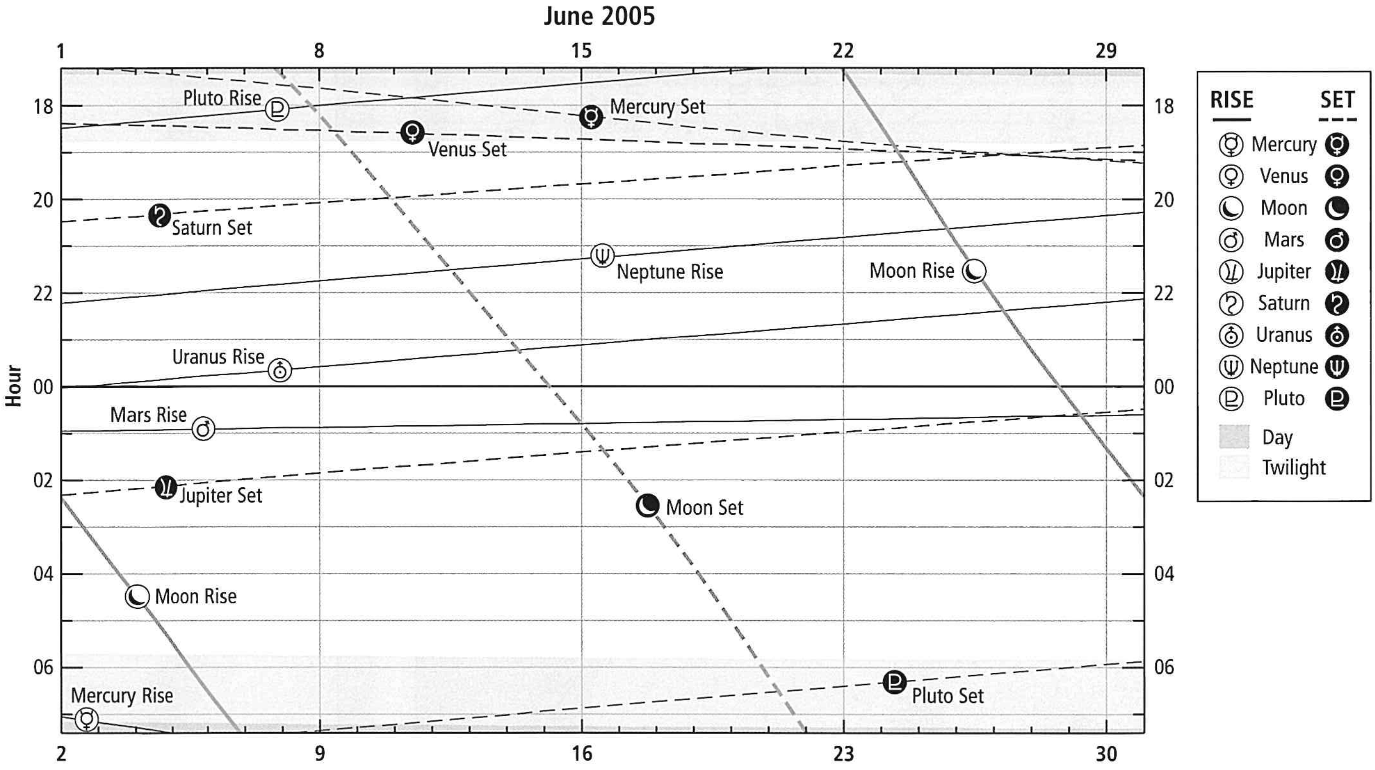


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0656	1708	0826	1823	0058	1328	1404	0223	1	1018	2029	0006	1251	2213	1141	1829	0753
2	0703	1712	0828	1824	0057	1326	1400	0219	2	1014	2025	0002	1247	2209	1137	1825	0749
2									2			2358					
3	0710	1716	0829	1825	0057	1324	1356	0215	3	1011	2022	2354	1243	2205	1133	1821	0745
4	0717	1720	0831	1826	0056	1322	1352	0211	4	1007	2018	2350	1239	2201	1129	1817	0741
5	0724	1725	0833	1828	0055	1320	1348	0207	5	1003	2015	2346	1235	2157	1125	1813	0737
6	0730	1729	0834	1829	0055	1318	1344	0203	6	1000	2012	2343	1231	2153	1121	1809	0733
7	0737	1734	0835	1831	0054	1316	1340	0159	7	0956	2008	2339	1227	2149	1117	1805	0729
8	0743	1738	0837	1832	0053	1314	1337	0155	8	0953	2005	2335	1224	2145	1113	1800	0725
9	0749	1743	0838	1834	0053	1312	1333	0151	9	0949	2001	2331	1220	2141	1109	1756	0721
10	0755	1748	0839	1835	0052	1310	1329	0147	10	0946	1958	2327	1216	2137	1105	1752	0717
11	0801	1753	0841	1837	0051	1308	1325	0143	11	0942	1955	2323	1212	2133	1101	1748	0713
12	0807	1758	0842	1838	0051	1306	1321	0140	12	0939	1951	2319	1208	2129	1058	1744	0709
13	0812	1803	0843	1840	0050	1304	1317	0136	13	0935	1948	2315	1204	2125	1054	1740	0705
14	0817	1808	0844	1842	0049	1302	1313	0132	14	0932	1944	2311	1200	2121	1050	1736	0701
15	0821	1813	0845	1843	0048	1300	1309	0128	15	0928	1941	2307	1156	2117	1046	1732	0656
16	0826	1818	0846	1845	0048	1258	1305	0124	16	0925	1938	2303	1152	2113	1042	1728	0652
17	0830	1823	0847	1847	0047	1256	1302	0121	17	0921	1934	2259	1148	2109	1038	1724	0648
18	0833	1828	0848	1849	0046	1254	1258	0117	18	0918	1931	2256	1144	2105	1034	1720	0644
19	0837	1832	0849	1850	0045	1252	1254	0113	19	0914	1928	2252	1140	2101	1030	1716	0640
20	0840	1837	0850	1852	0045	1250	1250	0109	20	0911	1924	2248	1136	2057	1026	1712	0636
21	0843	1841	0851	1854	0044	1248	1246	0106	21	0907	1921	2244	1132	2053	1022	1708	0632
22	0845	1846	0852	1856	0043	1245	1242	0102	22	0904	1917	2240	1129	2049	1018	1704	0628
23	0848	1850	0852	1858	0042	1243	1239	0058	23	0900	1914	2236	1125	2045	1014	1700	0624
24	0850	1854	0853	1859	0042	1241	1235	0055	24	0857	1911	2232	1121	2041	1010	1656	0620
25	0852	1858	0854	1901	0041	1239	1231	0051	25	0853	1907	2228	1117	2037	1006	1652	0616
26	0853	1901	0854	1903	0040	1237	1227	0047	26	0850	1904	2224	1113	2033	1002	1648	0612
27	0854	1905	0855	1905	0039	1235	1223	0044	27	0846	1901	2220	1109	2029	0958	1644	0608
28	0855	1908	0855	1907	0038	1233	1220	0040	28	0843	1857	2216	1105	2025	0954	1640	0604
29	0856	1911	0856	1909	0038	1231	1216	0036	29	0839	1854	2212	1101	2021	0950	1636	0600
30	0856	1914	0856	1911	0037	1229	1212	0033	30	0836	1851	2208	1057	2017	0946	1632	0556

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

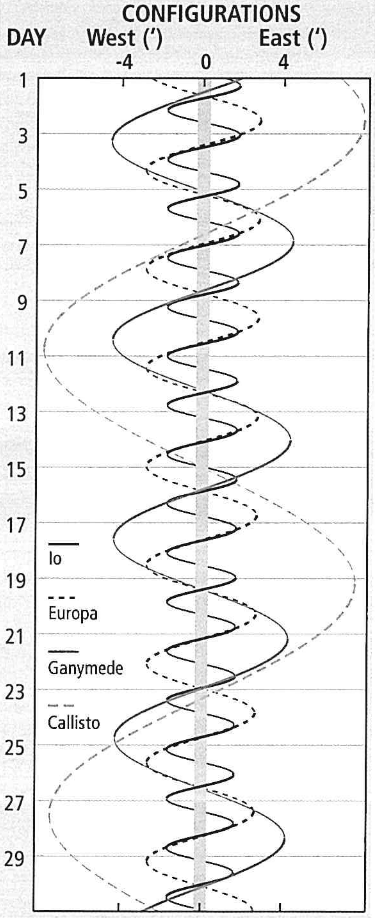
DAY	PHENOMENON h m	Sat.	Event
1	1811	I	Tr.E.
1	1848	II	Ec.R.
1	1917	I	Sh.E.
2	0150		GRS
2	2141		GRS
4	2320		GRS
4	2359	III	Oc.D.
5	1911		GRS
6	2138	II	Tr.I.
6	2322	I	Tr.I.
7	0002	II	Sh.I.
7	0020	II	Tr.E.
7	0032	I	Sh.I.
7	0059		GRS
7	0134	I	Tr.E.
7	2034	I	Oc.D.
7	2050		GRS
7	2358	I	Ec.R.
8	1750	I	Tr.I.
8	1835	III	Sh.I.
8	1900	I	Sh.I.
8	2002	I	Tr.E.
8	2102	III	Sh.E.
8	2111	I	Sh.E.
8	2122	II	Ec.R.
9	1826	I	Ec.R.
9	2229		GRS
10	1820		GRS
12	0007		GRS
12	1959		GRS
14	0009	II	Tr.I.
14	0113	I	Tr.I.
14	0146		GRS
14	2138		GRS
14	2226	I	Oc.D.
15	1729	III	Tr.I.
15	1852	II	Oc.D.
15	1941	I	Tr.I.
15	2011	III	Tr.E.
15	2055	I	Sh.I.
15	2153	I	Tr.E.
15	2234	III	Sh.I.
15	2306	I	Sh.E.
15	2357	II	Ec.R.
16	0100	III	Sh.E.
16	2022	I	Ec.R.
16	2316		GRS
17	1734	I	Sh.E.
17	1838	II	Sh.E.
17	1908		GRS
19	0055		GRS
19	2047		GRS
21	2225		GRS
22	0020	I	Oc.D.
22	1817		GRS
22	2119	III	Tr.I.
22	2123	II	Oc.D.
22	2134	I	Tr.I.
22	2250	I	Sh.I.
22	2346	I	Tr.E.
23	0003	III	Tr.E.
23	1848	I	Oc.D.
23	2217	I	Ec.R.
24	0004		GRS
24	1815	I	Tr.E.
24	1835	II	Sh.I.
24	1842	II	Tr.E.
24	1929	I	Sh.E.
24	1956		GRS
24	2115	II	Sh.E.
26	1910	III	Ec.R.
26	2135		GRS
28	2314		GRS
29	1905		GRS
29	2328	I	Tr.I.
29	2356	II	Oc.D.
30	2043	I	Oc.D.

Moons:
- I Io
- II Europa
- III Ganymede
- IV Callisto

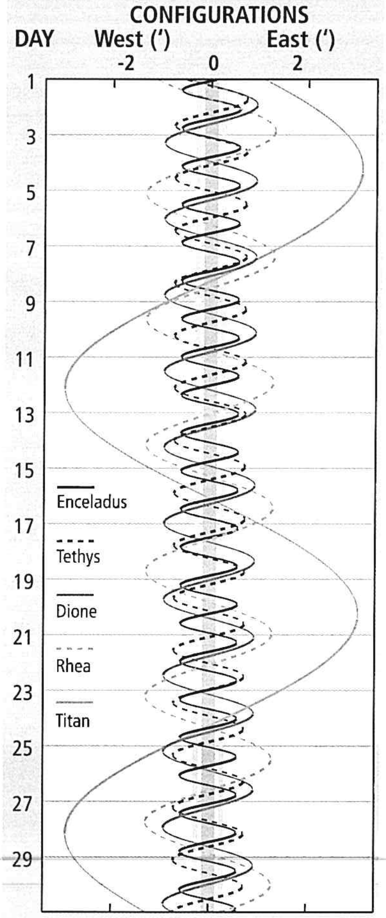
Events:
- D Disappear
- E Egress
- Ec Eclipse
- Sh Shadow
- R Reappear
- I Ingress
- Oc Occult
- Tr Transit

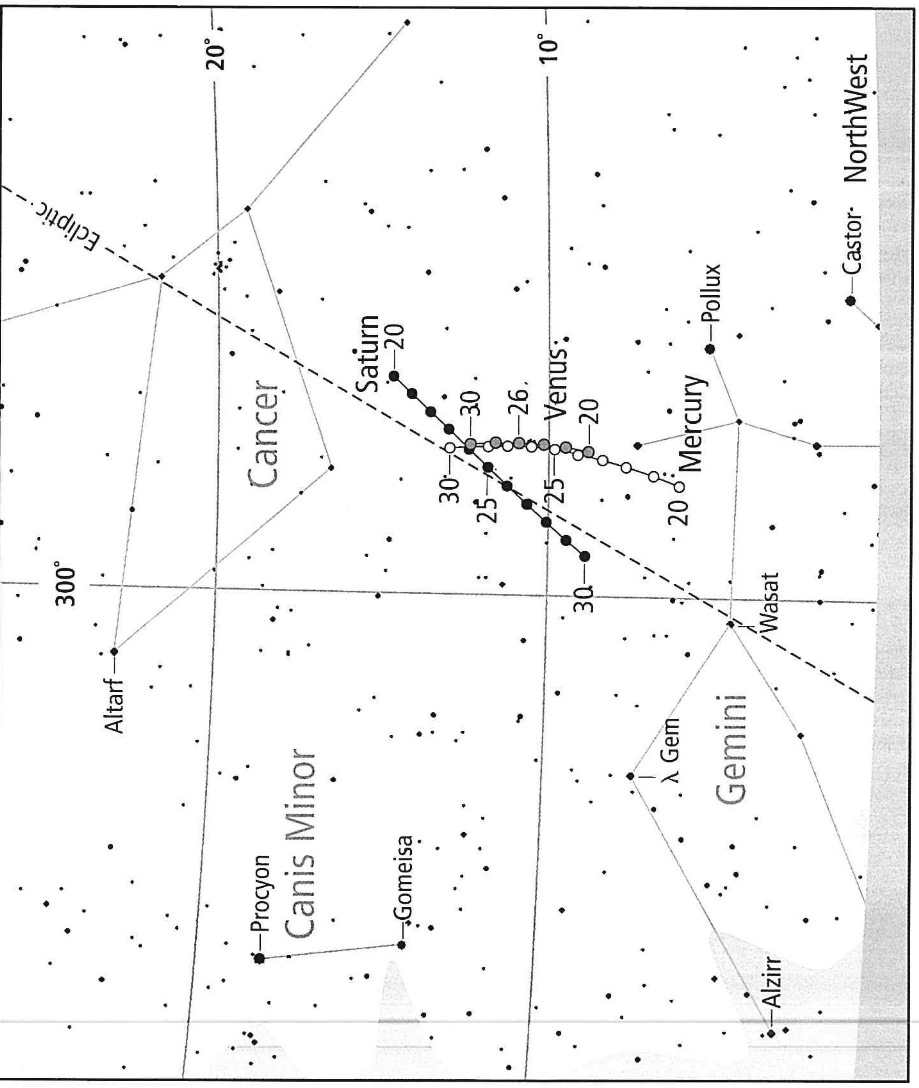
GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

JUPITER MOONS

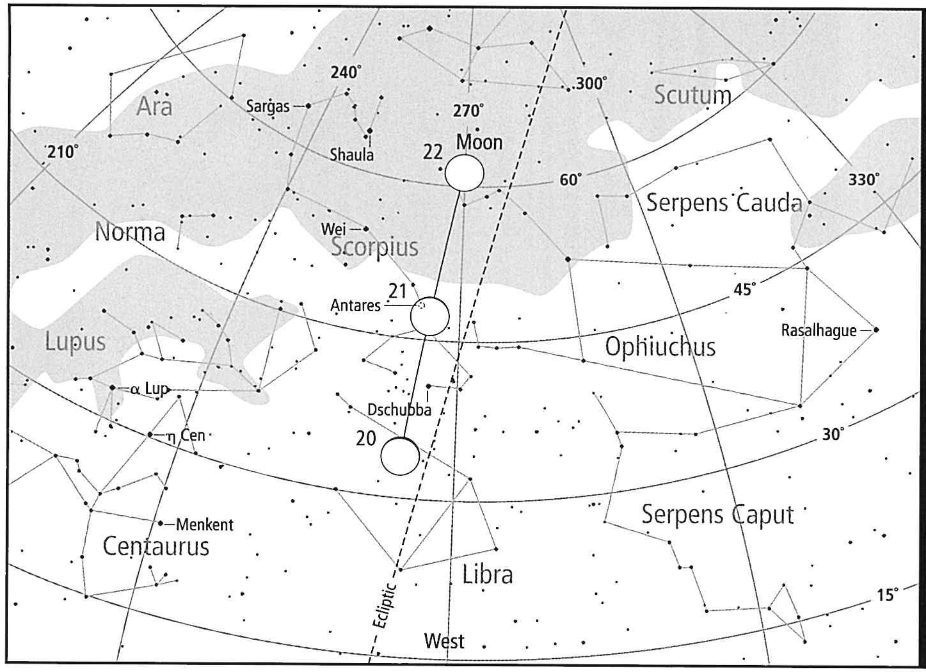


SATURN MOONS

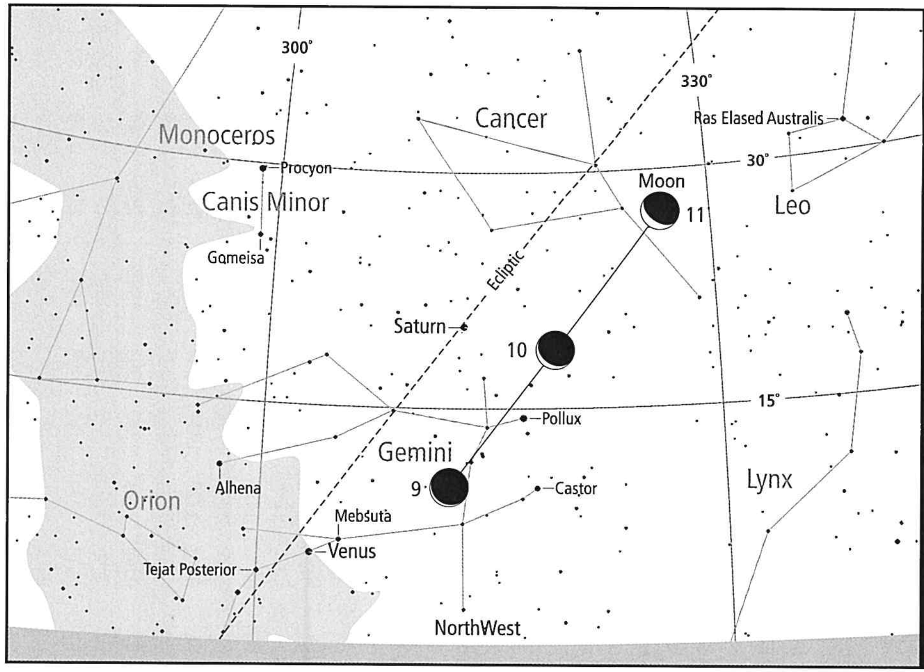




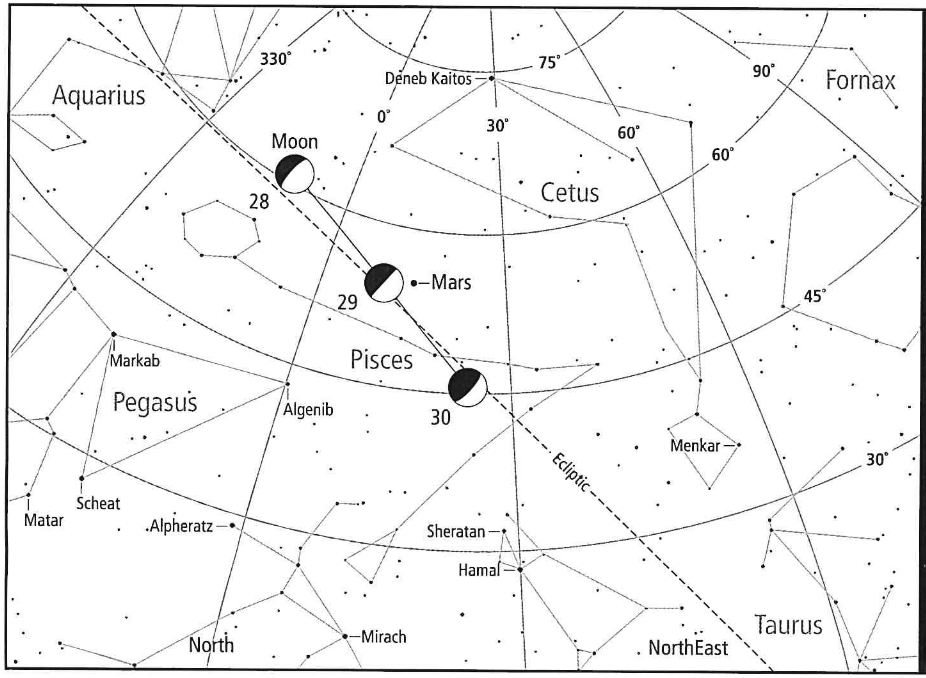
SKYVIEW 2005 JUNE 20-30 6pm



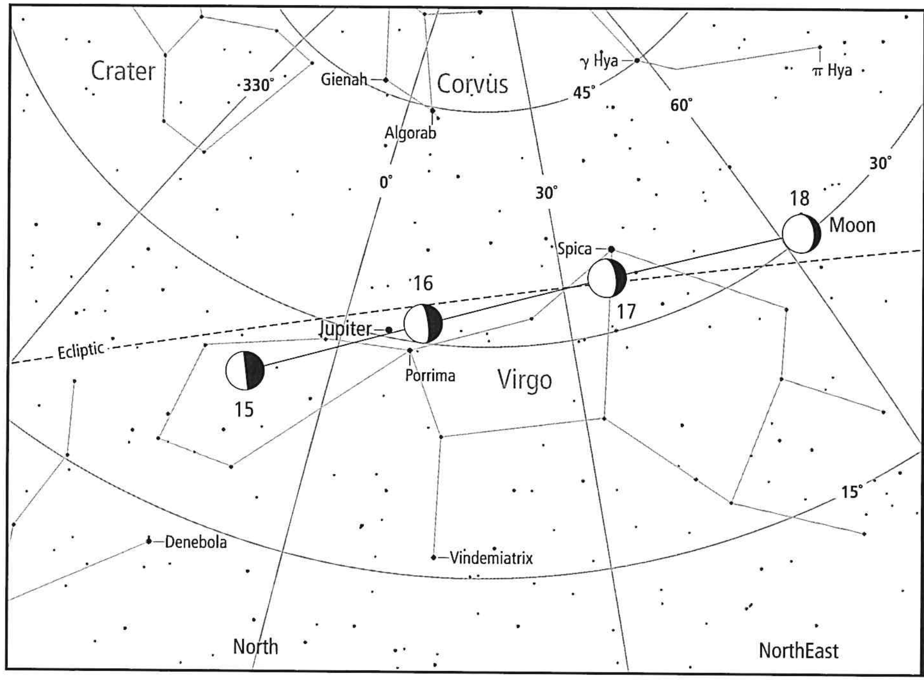
SKYVIEW 2005 JUNE 20-22 2am



SKYVIEW 2005 JUNE 9-11 6pm



SKYVIEW 2005 JUNE 28-30 6am



SKYVIEW 2005 JUNE 15-18 7pm

JULY 2005

HIGHLIGHTS

***Mercury** visible in the evening, low in the west-northwest after civil twilight.*

***Venus** easily visible in the early evening western sky. Conjunction with Mercury on the 7th.*

***Mars** rises after midnight in Pisces.*

***Jupiter** visible in the evening in Virgo.*

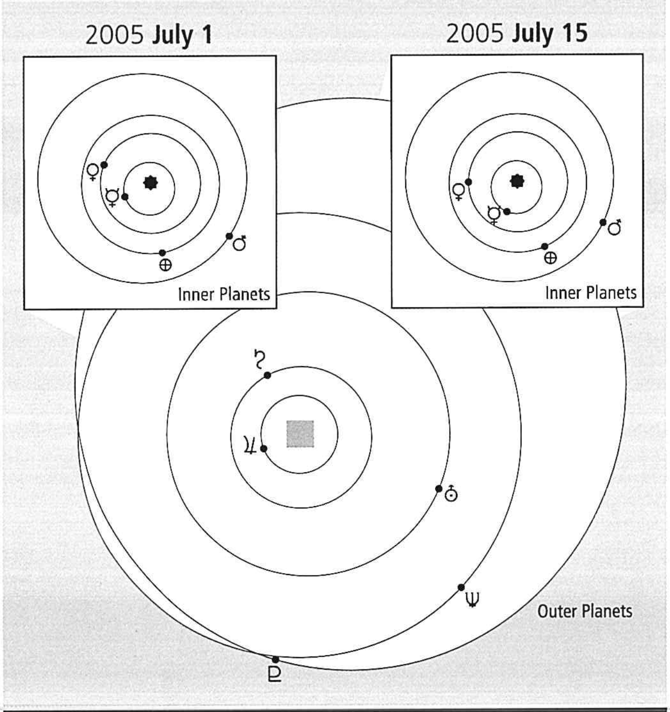
DIARY

Day	Hour	
5	13	Earth at aphelion
6	20	**New Moon**
7	16	Mercury 1.°6 S. of Venus - Conjunction
9		Maximum activity of Pegasid meteor shower
9	02	Mercury 5° S. of Moon
9	02	Moon at apogee
9	03	Venus 3° S. of Moon
9	11	Mercury greatest elongation E. (26°)
14	02	Jupiter 0.°8 N. of Moon
14	23	**First Quarter**
18	12	Antares 0.°6 S. of Moon
21	19	**Full Moon**
22	04	Moon at perigee
22	13	Mercury stationary
22	23	Venus 1.°2 N. of Regulus
24	01	Saturn in conjunction with Sun
27		Maximum activity of Piscis Austrinid meteor shower
28		Maximum activity of delta-Aquarid S. meteor shower
28	04	Mars 4° S. of Moon
28	11	**Last Quarter**
29		Maximum activity of alpha-Capricornid meteor shower

SUN+MOON RISE/SET

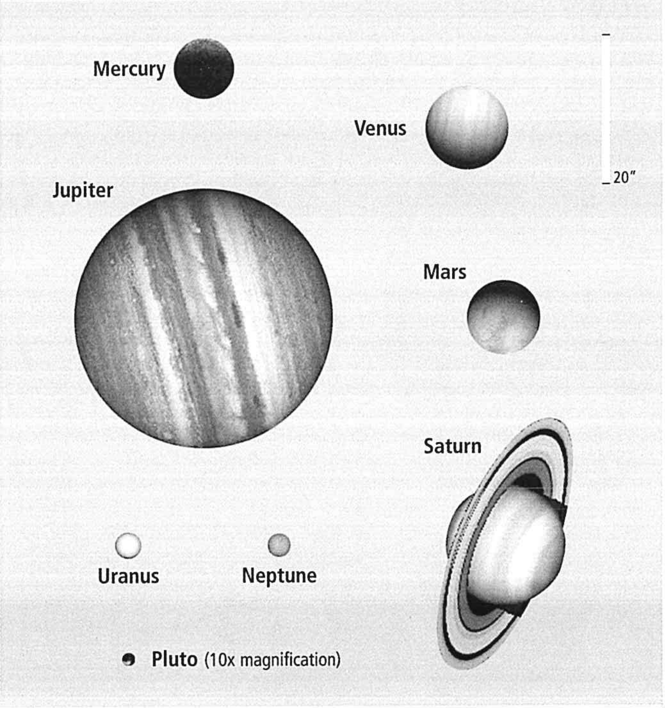
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0718	63	0551	1220	1723	297	1850	0221	1323	27
2	0718	63	0551	1221	1724	297	1851	0322	1356	19
3	0718	63	0551	1221	1724	297	1851	0424	1434	11
4	0718	63	0551	1221	1724	297	1851	0525	1518	6
5	0718	63	0551	1221	1725	297	1852	0622	1607	2
6	0717	64	0550	1221	1725	296	1852	0715	1700	0
7	0717	64	0550	1221	1726	296	1853	0802	1757	0
8	0717	64	0550	1222	1726	296	1853	0843	1855	2
9	0717	64	0550	1222	1727	296	1853	0918	1952	6
10	0717	64	0550	1222	1727	296	1854	0948	2049	11
11	0716	64	0550	1222	1728	296	1854	1016	2144	17
12	0716	64	0550	1222	1728	296	1855	1042	2240	25
13	0716	65	0550	1222	1729	295	1855	1107	2335	34
14	0716	65	0549	1222	1729	295	1856	1133	DNS	44
15	0715	65	0549	1223	1730	295	1856	1201	0033	54
16	0715	65	0549	1223	1731	295	1857	1233	0134	64
17	0714	65	0549	1223	1731	295	1857	1311	0240	74
18	0714	66	0548	1223	1732	294	1858	1357	0349	83
19	0714	66	0548	1223	1732	294	1858	1453	0459	91
20	0713	66	0548	1223	1733	294	1859	1600	0607	97
21	0713	66	0547	1223	1734	294	1859	1714	0709	100
22	0712	66	0547	1223	1734	293	1900	1831	0800	99
23	0712	67	0546	1223	1735	293	1900	1946	0844	96
24	0711	67	0546	1223	1735	293	1901	2057	0921	90
25	0710	67	0545	1223	1736	293	1901	2205	0953	82
26	0710	67	0545	1223	1737	292	1902	2309	1024	73
27	0709	68	0544	1223	1737	292	1902	DNR	1053	62
28	0709	68	0544	1223	1738	292	1903	0013	1124	52
29	0708	68	0543	1223	1739	292	1903	0116	1157	41
30	0707	69	0543	1223	1739	291	1904	0218	1234	31
31	0706	69	0542	1223	1740	291	1904	0319	1316	23

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

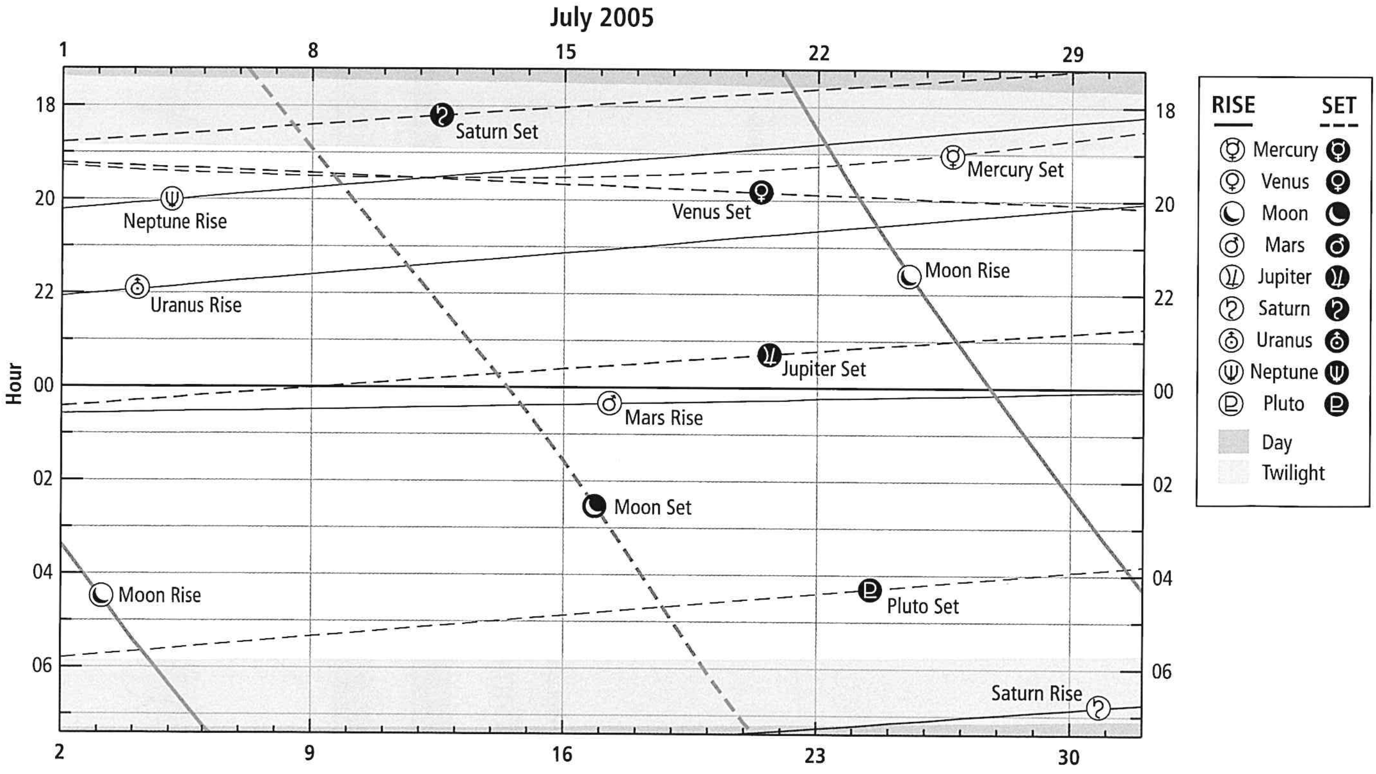


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0857	1917	0857	1913	0036	1227	1208	0029	1	0833	1847	2204	1053	2013	0942	1628	0552
2	0857	1919	0857	1915	0035	1225	1205	0025	2	0829	1844	2200	1049	2009	0938	1624	0548
3	0856	1922	0857	1917	0034	1223	1201	0022	3	0826	1841	2156	1045	2005	0934	1619	0544
4	0856	1924	0857	1919	0033	1221	1157	0018	4	0822	1837	2152	1041	2001	0930	1615	0540
5	0855	1926	0857	1920	0032	1218	1153	0015	5	0819	1834	2148	1037	1957	0926	1611	0536
6	0855	1927	0858	1922	0031	1216	1150	0011	6	0815	1831	2144	1033	1953	0922	1607	0532
7	0853	1929	0858	1924	0031	1214	1146	0008	7	0812	1827	2140	1029	1949	0918	1603	0528
8	0852	1930	0858	1926	0030	1212	1142	0004	8	0808	1824	2136	1025	1945	0914	1559	0524
9	0851	1931	0858	1928	0029	1210	1139	0001	9	0805	1821	2132	1021	1941	0910	1555	0520
9								2357									
10	0849	1932	0858	1930	0028	1208	1135	2354	10	0801	1817	2128	1017	1937	0906	1551	0516
11	0847	1932	0858	1932	0027	1206	1131	2350	11	0758	1814	2124	1013	1933	0902	1547	0512
12	0845	1932	0857	1934	0026	1204	1127	2347	12	0754	1811	2120	1009	1929	0858	1543	0508
13	0843	1932	0857	1936	0025	1201	1124	2343	13	0751	1807	2116	1005	1925	0854	1539	0504
14	0840	1932	0857	1938	0024	1159	1120	2340	14	0747	1804	2112	1001	1921	0850	1535	0500
15	0837	1931	0857	1940	0023	1157	1117	2336	15	0744	1801	2108	0957	1916	0846	1531	0456
16	0834	1930	0857	1941	0022	1155	1113	2333	16	0740	1757	2104	0953	1912	0842	1527	0452
17	0831	1928	0856	1943	0021	1153	1109	2330	17	0737	1754	2100	0949	1908	0838	1523	0448
18	0827	1927	0856	1945	0020	1151	1106	2326	18	0733	1751	2056	0945	1904	0834	1519	0444
19	0824	1924	0856	1947	0019	1149	1102	2323	19	0730	1747	2051	0941	1900	0830	1515	0440
20	0820	1922	0855	1949	0018	1146	1058	2320	20	0727	1744	2047	0937	1856	0826	1511	0436
21	0816	1919	0855	1951	0017	1144	1055	2316	21	0723	1741	2043	0933	1852	0822	1507	0432
22	0811	1916	0854	1953	0016	1142	1051	2313	22	0720	1737	2039	0929	1848	0818	1503	0428
23	0807	1912	0854	1954	0014	1140	1047	2309	23	0716	1734	2035	0925	1844	0814	1459	0424
24	0802	1908	0853	1956	0013	1138	1044	2306	24	0713	1731	2031	0921	1840	0810	1455	0420
25	0757	1904	0853	1958	0012	1135	1040	2303	25	0709	1728	2027	0917	1836	0806	1451	0416
26	0752	1859	0852	2000	0011	1133	1037	2259	26	0706	1724	2023	0913	1832	0802	1447	0412
27	0746	1854	0852	2002	0010	1131	1033	2256	27	0702	1721	2019	0909	1828	0758	1443	0408
28	0740	1848	0851	2003	0009	1129	1029	2253	28	0659	1718	2015	0905	1824	0754	1439	0404
29	0735	1842	0850	2005	0007	1127	1026	2250	29	0655	1714	2011	0901	1820	0750	1435	0400
30	0729	1836	0850	2007	0006	1124	1022	2246	30	0652	1711	2007	0857	1816	0746	1431	0356
31	0723	1830	0849	2009	0005	1122	1019	2243	31	0648	1708	2003	0853	1812	0742	1427	0352

SOLAR SYSTEM RISE/SET

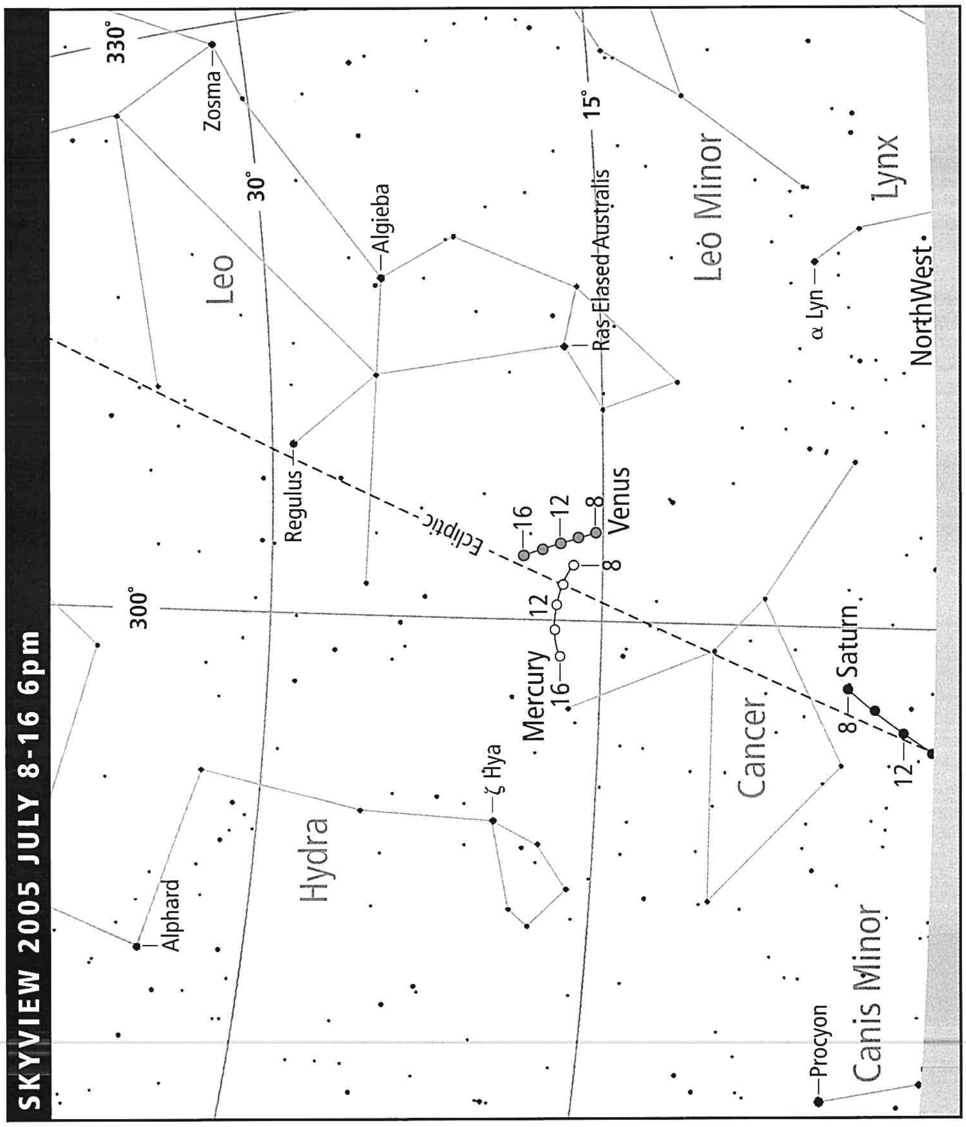


JUPITER MOONS + GREAT RED SPOT

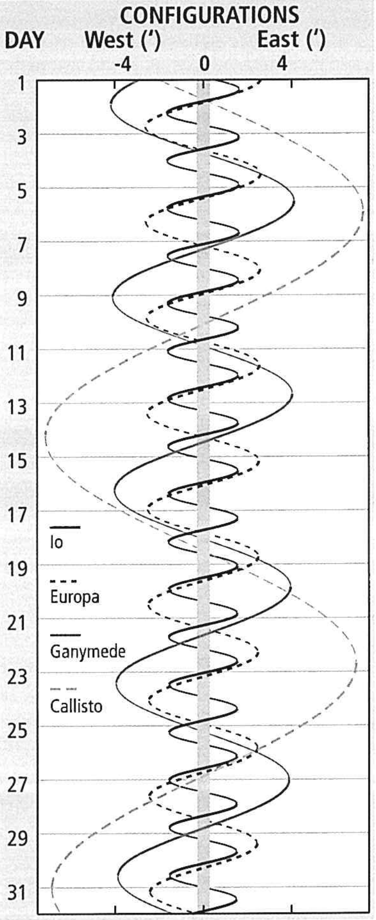
DAY	PHENOMENON h m	Sat.	Event	DAY	PHENOMENON h m	Sat.	Event	DAY	PHENOMENON h m	Sat.	Event	DAY	PHENOMENON h m	Sat.	Event
1	0012	I	Ec.R.	3	2044	III	Ec.D.	8	2350	II	Sh.I.	21	2052	III	Sh.E.
1	1757	I	Tr.I.	3	2223		GRS	8	2357	II	Tr.E.	22	2310		GRS
1	1835	II	Tr.I.	3	2308	III	Ec.R.	9	2036	I	Ec.R.	23	1901		GRS
1	1913	I	Sh.I.	4	1814		GRS	10	1747	I	Sh.E.	23	2101	I	Oc.D.
1	2009	I	Tr.E.	6	0002		GRS	10	1926	III	Oc.D.	24	1813	I	Tr.I.
1	2044		GRS	6	1953		GRS	10	2057	II	Ec.R.	24	1925	I	Sh.I.
1	2113	II	Sh.I.	7	2238	I	Oc.D.	10	2212	III	Oc.R.	24	2026	I	Tr.E.
1	2119	II	Tr.E.	8	1952	I	Tr.I.	10	2311		GRS	24	2105	II	Oc.D.
1	2124	I	Sh.E.	8	2107	I	Sh.I.	11	1903		GRS	24	2136	I	Sh.E.
1	2353	II	Sh.E.	8	2114	II	Tr.I.	13	2042		GRS	25	1855	I	Ec.R.
2	1841	I	Ec.R.	8	2132		GRS	15	2147	I	Tr.I.	25	2040		GRS
3	1810	III	Oc.R.	8	2204	I	Tr.E.	15	2221		GRS	26	1824	II	Sh.I.
3	1822	II	Ec.R.	8	2318	I	Sh.E.	15	2302	I	Sh.I.	26	1841	II	Tr.E.
								16	1813		GRS	26	2103	II	Sh.E.
								16	1904	I	Oc.D.	27	2219		GRS
								16	2231	I	Ec.R.	28	1811		GRS
								17	1826	II	Oc.D.	28	2019	III	Tr.E.
								17	1829	I	Tr.E.	28	2229	III	Sh.I.
								17	1941	I	Sh.E.	30	1950		GRS
								18	1952		GRS	31	2011	I	Tr.I.
								19	1826	II	Sh.E.	31	2120	I	Sh.I.
								20	2131		GRS	31	2223	I	Tr.E.
								21	1830	III	Sh.I.				

Moons:	I	Io	III	Ganymede
	II	Europa	IV	Callisto
Events:	D	Disappear	R	Reappear
	E	Egress	I	Ingress
	Ec	Eclipse	Oc	Occult
	Sh	Shadow	Tr	Transit
	GRS	Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown		

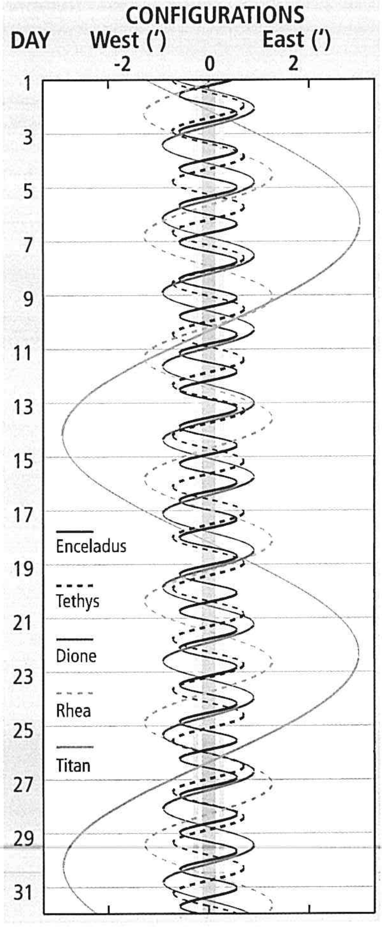
SKYVIEW 2005 JULY 8-16 6pm

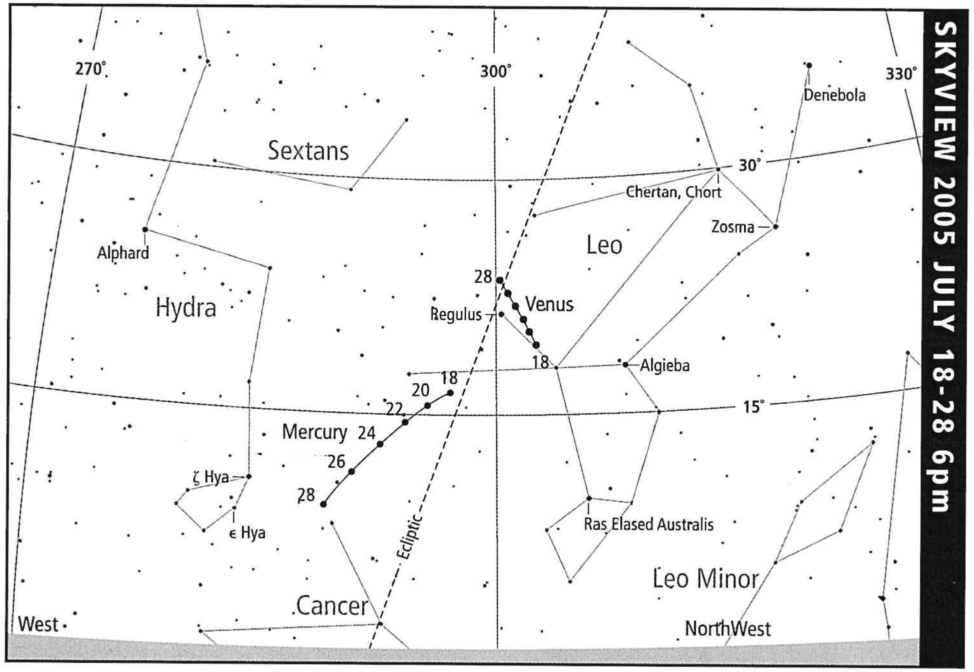


JUPITER MOONS

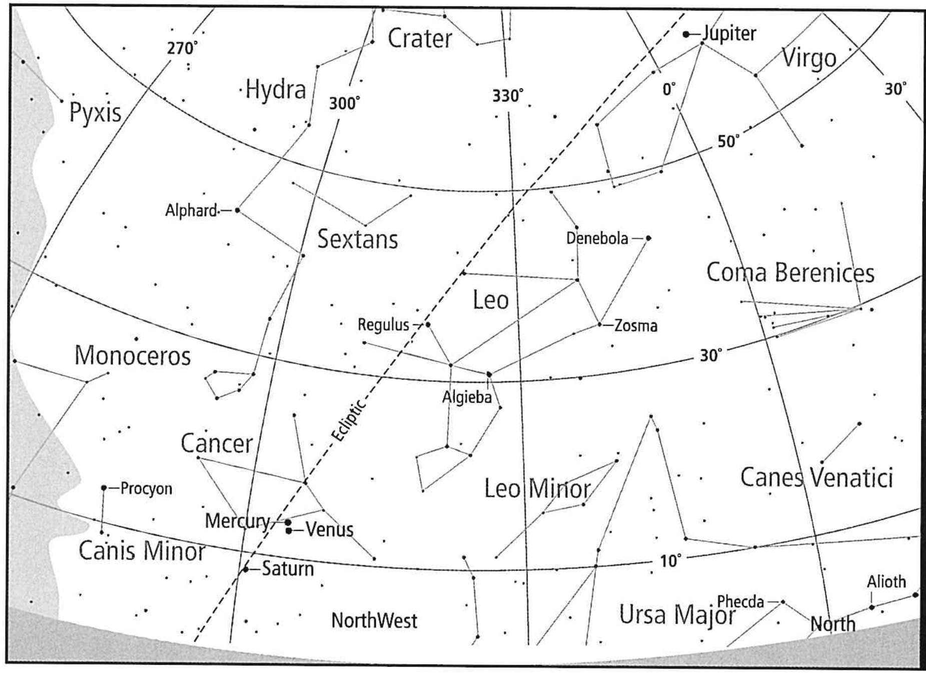


SATURN MOONS

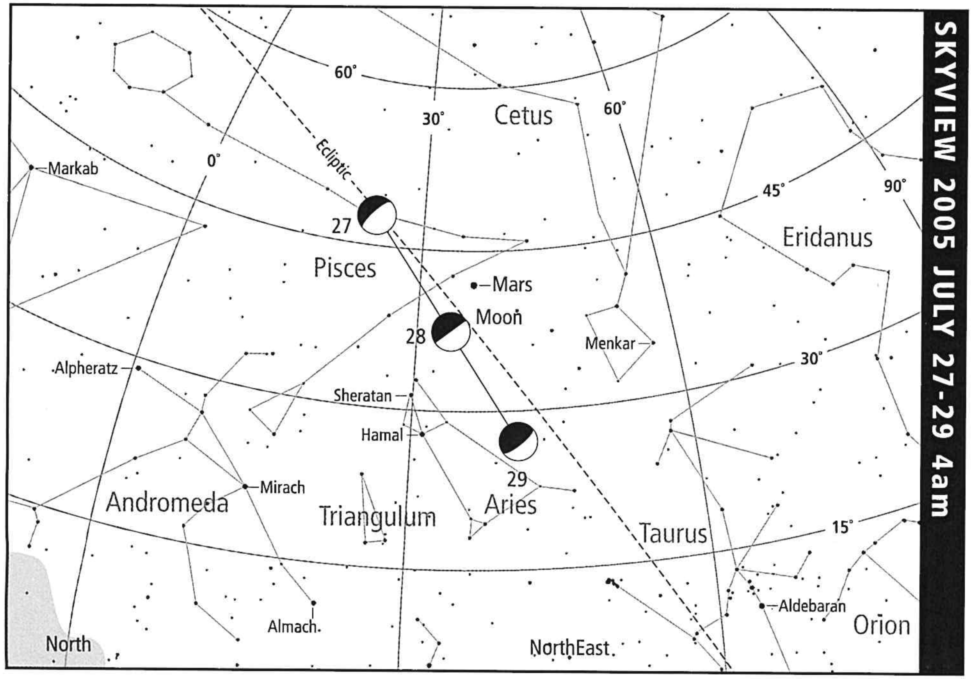




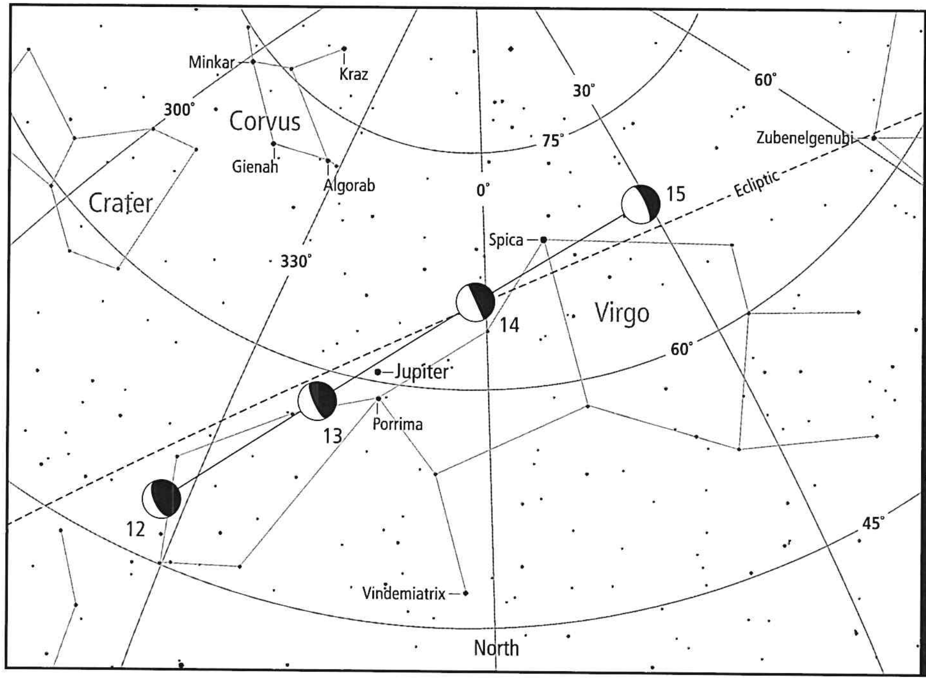
SKYVIEW 2005 JULY 18-28 6pm



SKYVIEW 2005 JULY 1 6pm



SKYVIEW 2005 JULY 27-29 4am



SKYVIEW 2005 JULY 12-15 6pm

AUGUST 2005

HIGHLIGHTS

Mercury *visible in the mornings in second half of month, low in the east before civil twilight.*

Venus *easily visible in the evening sky. On the 8th Venus may be visible to the unaided eye close to the Moon (**Do NOT look at the Sun**).*

Mars *rises around midnight.*

Jupiter *visible in the evening sky in constellation Virgo. On the 10th Jupiter may be visible to the unaided eye close to the Moon (**Do NOT look at the Sun**).*

Saturn *rises before sunrise in Cancer.*

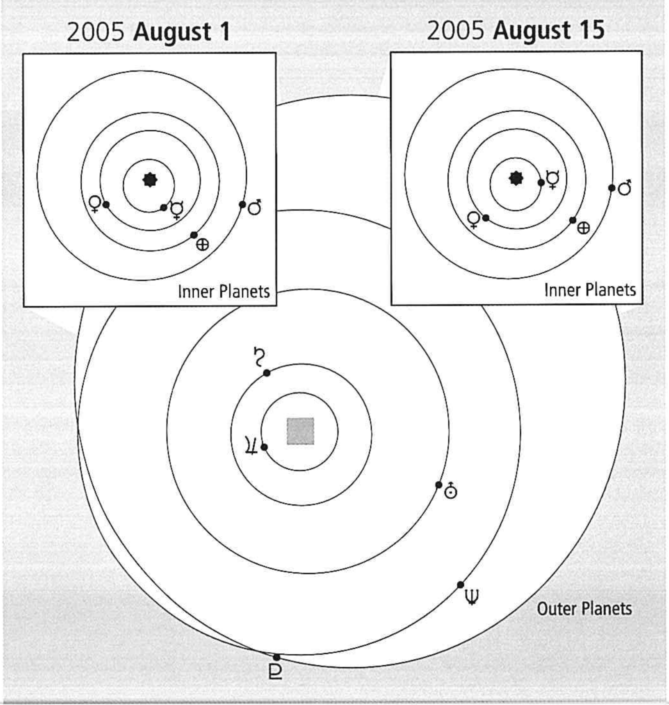
DIARY

Day	Hour	
4		Maximum activity of iota-Aquarid S. meteor shower
5	06	Moon at apogee
5	11	**New Moon**
6	08	Mercury in inferior conjunction
8		Maximum activity of delta-Aquarid N. meteor shower
8	12	Venus 1.°2 S. of Moon
10	16	Jupiter 1.°3 N. of Moon
13	11	**First Quarter**
14	21	Antares 0.°4 S. of Moon
15	21	Mercury stationary
19		Maximum activity of iota-Aquarid N. meteor shower
19	14	Moon at perigee
20	02	**Full Moon**
24	07	Mercury greatest elongation W. (18°)
25	15	Mars 6° S. of Moon
26	23	**Last Quarter**

SUN+MOON RISE/SET

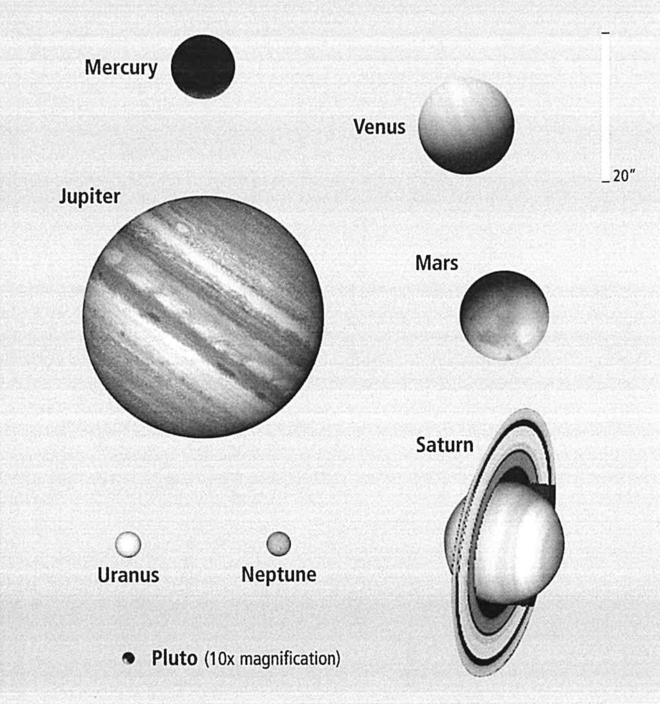
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0706	69	0542	1223	1740	291	1905	0418	1403	15
2	0705	69	0541	1223	1741	290	1905	0512	1455	9
3	0704	70	0540	1223	1742	290	1906	0601	1551	4
4	0703	70	0540	1223	1742	290	1906	0643	1649	1
5	0702	70	0539	1223	1743	289	1907	0719	1746	0
6	0702	71	0538	1222	1744	289	1907	0751	1843	1
7	0701	71	0537	1222	1744	289	1908	0819	1939	3
8	0700	71	0537	1222	1745	288	1908	0846	2034	7
9	0659	72	0536	1222	1746	288	1909	0911	2130	13
10	0658	72	0535	1222	1746	288	1909	0936	2226	20
11	0657	72	0534	1222	1747	287	1910	1002	2325	29
12	0656	73	0533	1222	1748	287	1910	1032	DNS	39
13	0655	73	0532	1221	1748	287	1911	1106	0027	49
14	0654	73	0532	1221	1749	286	1911	1147	0132	60
15	0653	74	0531	1221	1749	286	1912	1237	0240	70
16	0652	74	0530	1221	1750	286	1913	1338	0348	80
17	0651	75	0529	1221	1751	285	1913	1447	0451	89
18	0650	75	0528	1220	1751	285	1914	1603	0547	95
19	0649	75	0527	1220	1752	284	1914	1719	0634	99
20	0648	76	0526	1220	1753	284	1915	1833	0714	100
21	0647	76	0525	1220	1753	284	1915	1944	0749	98
22	0646	77	0524	1220	1754	283	1916	2052	0821	93
23	0644	77	0523	1219	1754	283	1916	2158	0851	85
24	0643	77	0522	1219	1755	282	1917	2304	0922	77
25	0642	78	0521	1219	1756	282	1917	DNR	0955	67
26	0641	78	0519	1218	1756	282	1918	0008	1032	57
27	0640	79	0518	1218	1757	281	1918	0111	1112	47
28	0639	79	0517	1218	1758	281	1919	0212	1158	37
29	0637	79	0516	1218	1758	280	1920	0308	1249	28
30	0636	80	0515	1217	1759	280	1920	0358	1345	20
31	0635	80	0514	1217	1759	280	1921	0443	1442	13

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

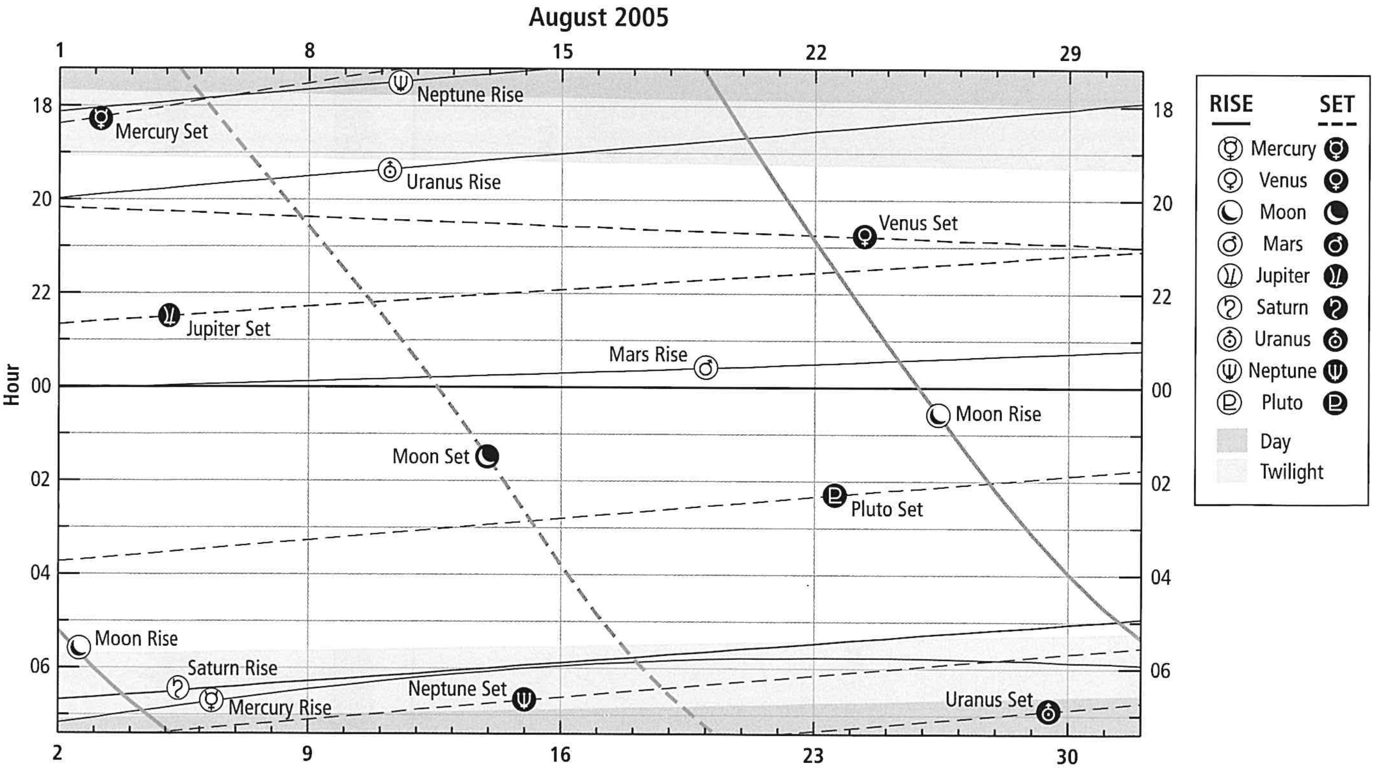


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0716	1823	0848	2010	0004	1120	1015	2240	1	0645	1704	1959	0849	1808	0738	1423	0348
2	0710	1816	0847	2012	0002	1118	1012	2236	2	0641	1701	1954	0845	1803	0734	1419	0344
3	0704	1808	0847	2014	0001	1115	1008	2233	3	0638	1658	1950	0841	1759	0730	1415	0340
4	0657	1801	0846	2015	0000	1113	1005	2230	4	0634	1654	1946	0837	1755	0726	1411	0336
4					2358				4								
5	0651	1753	0845	2017	2357	1111	1001	2227	5	0631	1651	1942	0833	1751	0722	1407	0332
6	0645	1746	0844	2019	2356	1108	0957	2224	6	0627	1648	1938	0829	1747	0718	1403	0328
7	0639	1738	0844	2021	2354	1106	0954	2220	7	0624	1644	1934	0825	1743	0714	1359	0324
8	0633	1731	0843	2022	2353	1104	0950	2217	8	0620	1641	1930	0821	1739	0710	1355	0320
9	0627	1723	0842	2024	2351	1101	0947	2214	9	0617	1638	1926	0817	1735	0706	1351	0316
10	0622	1716	0841	2026	2350	1059	0943	2211	10	0614	1634	1922	0813	1731	0702	1347	0312
11	0617	1710	0840	2027	2348	1057	0940	2208	11	0610	1631	1918	0809	1727	0658	1343	0308
12	0612	1703	0839	2029	2347	1054	0936	2204	12	0607	1628	1914	0805	1723	0653	1339	0304
13	0608	1657	0838	2030	2345	1052	0933	2201	13	0603	1624	1909	0801	1719	0649	1335	0300
14	0604	1652	0837	2032	2344	1050	0929	2158	14	0600	1621	1905	0757	1715	0645	1331	0256
15	0600	1647	0836	2034	2342	1047	0926	2155	15	0556	1618	1901	0753	1711	0641	1327	0252
16	0557	1642	0835	2035	2340	1045	0922	2152	16	0553	1614	1857	0749	1707	0637	1323	0248
17	0554	1638	0835	2037	2339	1042	0919	2149	17	0549	1611	1853	0745	1703	0633	1319	0244
18	0552	1635	0834	2039	2337	1040	0915	2145	18	0546	1608	1849	0741	1658	0629	1315	0240
19	0550	1632	0833	2040	2335	1037	0912	2142	19	0542	1604	1845	0737	1654	0625	1311	0236
20	0548	1630	0832	2042	2334	1035	0909	2139	20	0539	1601	1841	0733	1650	0621	1307	0232
21	0547	1628	0831	2043	2332	1032	0905	2136	21	0535	1558	1837	0729	1646	0617	1303	0228
22	0547	1627	0830	2045	2330	1030	0902	2133	22	0532	1554	1832	0724	1642	0613	1259	0224
23	0546	1627	0829	2047	2328	1027	0858	2130	23	0528	1551	1828	0720	1638	0609	1255	0220
24	0546	1627	0828	2048	2326	1025	0855	2127	24	0524	1548	1824	0716	1634	0605	1251	0216
25	0546	1628	0827	2050	2324	1022	0851	2124	25	0521	1544	1820	0712	1630	0601	1247	0212
26	0547	1629	0826	2052	2322	1019	0848	2121	26	0517	1541	1816	0708	1626	0557	1243	0209
27	0548	1631	0825	2053	2320	1017	0844	2118	27	0514	1537	1812	0704	1622	0553	1239	0205
28	0549	1633	0824	2055	2318	1014	0841	2114	28	0510	1534	1808	0700	1618	0549	1235	0201
29	0550	1636	0823	2056	2316	1011	0837	2111	29	0507	1531	1804	0656	1614	0545	1231	0157
30	0552	1639	0822	2058	2314	1009	0834	2108	30	0503	1527	1759	0652	1610	0541	1227	0153
31	0553	1642	0821	2100	2312	1006	0831	2105	31	0500	1524	1755	0648	1606	0537	1223	0149

SOLAR SYSTEM RISE/SET

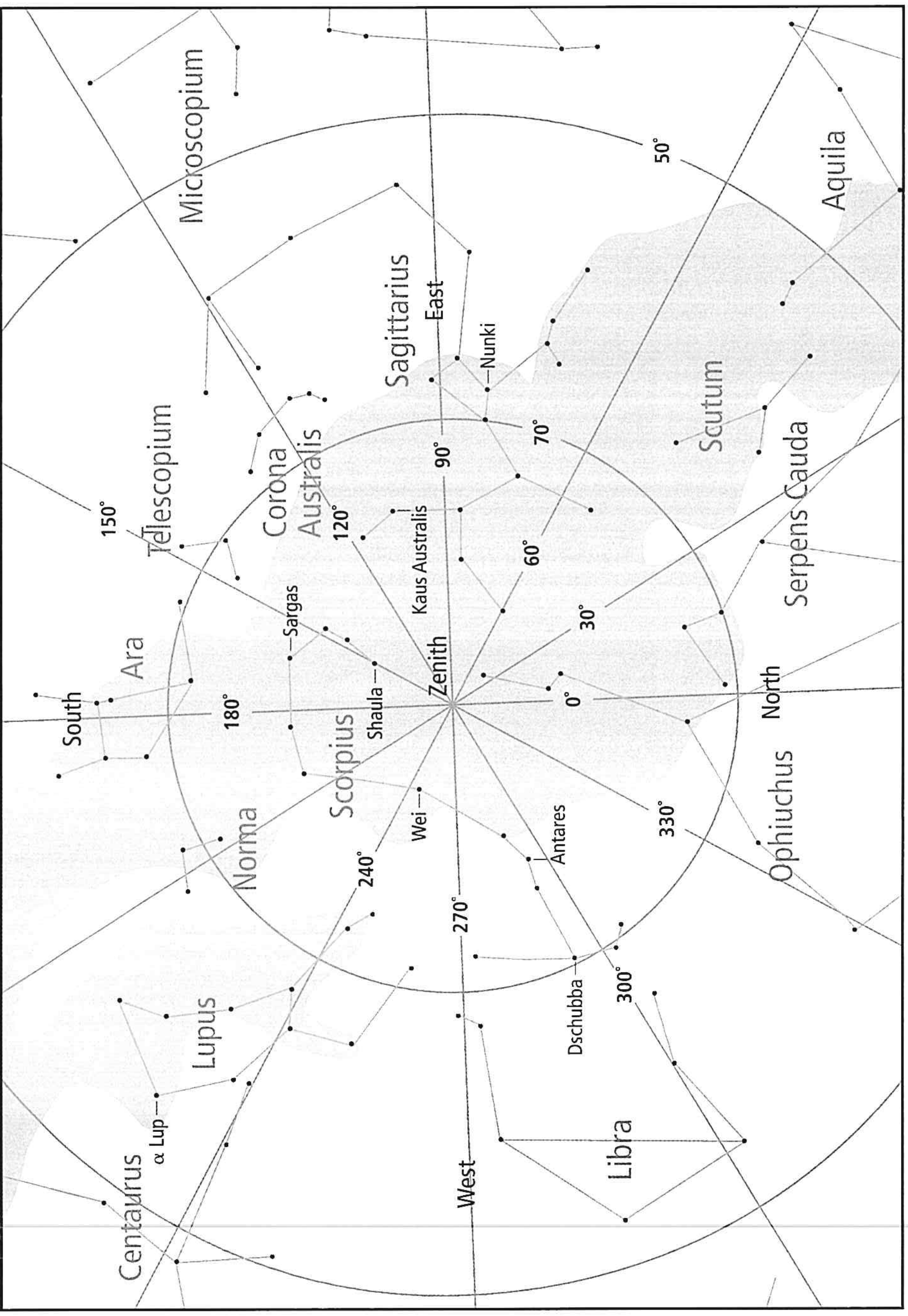


JUPITER MOONS + GREAT RED SPOT

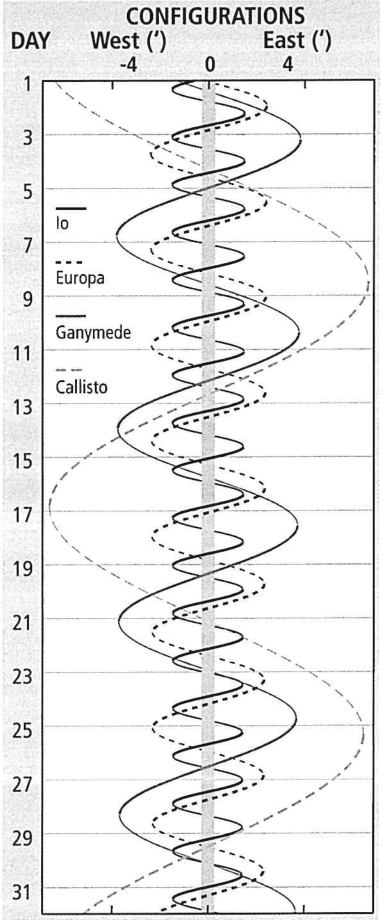
DAY	PHENOMENON			DAY	PHENOMENON			DAY	PHENOMENON			DAY	PHENOMENON		
	h m	Sat.	Event		h m	Sat.	Event		h m	Sat.	Event		h m	Sat.	Event
1	2050	I	Ec.R.	4	1900		GRS	9	1810		GRS	18	2038		GRS
1	2129		GRS	4	2147	III	Tr.I.	9	1851	I	Tr.E.	20	1811	II	Sh.E.
2	1759	I	Sh.E.	6	2039		GRS	9	1954	I	Sh.E.	22	2044	III	Oc.D.
2	1841	II	Tr.I.	7	2209	I	Tr.I.	9	2126	II	Tr.I.	23	1948		GRS
2	2101	II	Sh.I.	8	1901	III	Ec.R.	11	1949		GRS	23	2037	I	Tr.I.
2	2124	II	Tr.E.	8	1928	I	Oc.D.	11	2033	II	Ec.R.	24	1757	I	Oc.D.
4	1758	II	Ec.R.	8	2218		GRS	13	2128		GRS	24	2104	I	Ec.R.
								15	1908	III	Oc.R.	25	1812	I	Sh.E.
								15	2041	III	Ec.D.	25	2117	II	Oc.D.
								15	2127	I	Oc.D.	25	2128		GRS
								16	1838	I	Tr.I.	27	1809	II	Sh.I.
								16	1859		GRS	27	1905	II	Tr.E.
								16	1938	I	Sh.I.	27	2047	II	Sh.E.
								16	2050	I	Tr.E.	28	1858		GRS
								16	2148	I	Sh.E.	30	2038		GRS
								17	1909	I	Ec.R.	31	1958	I	Oc.D.
								18	1832	II	Oc.D.				

Moons:	I	Io	III	Ganymede
	II	Europa	IV	Callisto
Events:	D	Disappear	R	Reappear
	E	Egress	I	Ingress
	Ec	Eclipse	Oc	Occult
	Sh	Shadow	Tr	Transit
	GRS	Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown		

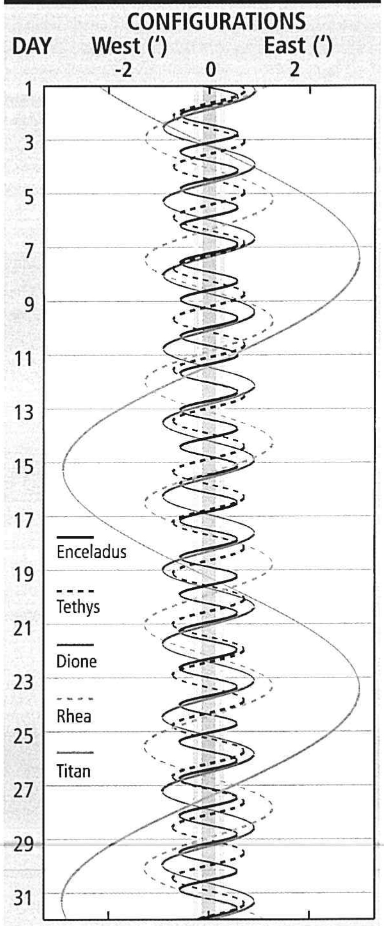
SKYVIEW AUGUST 15 8pm – ZENITH (OVERHEAD)



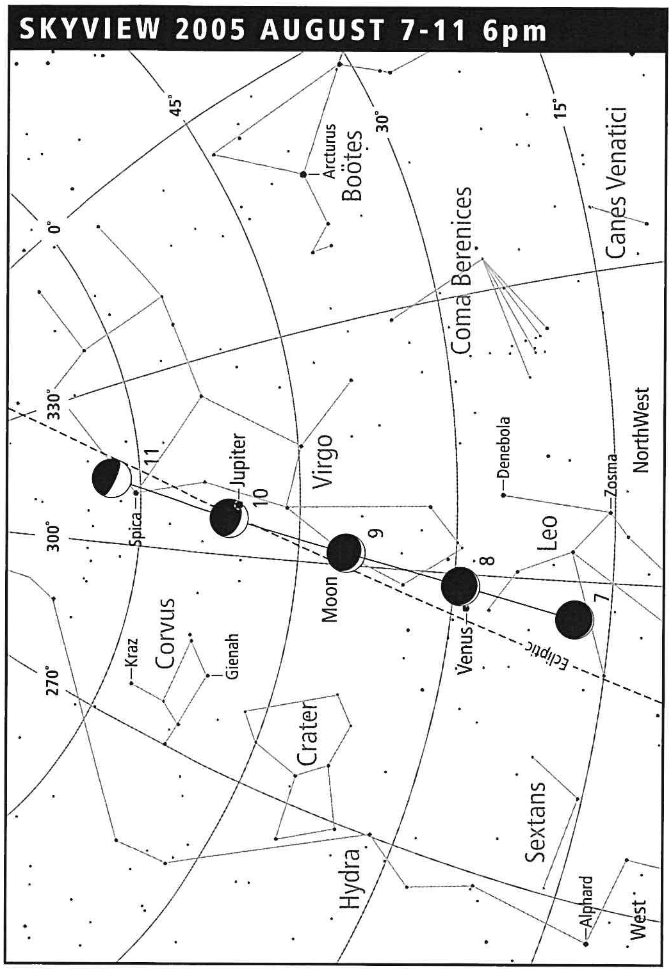
JUPITER MOONS



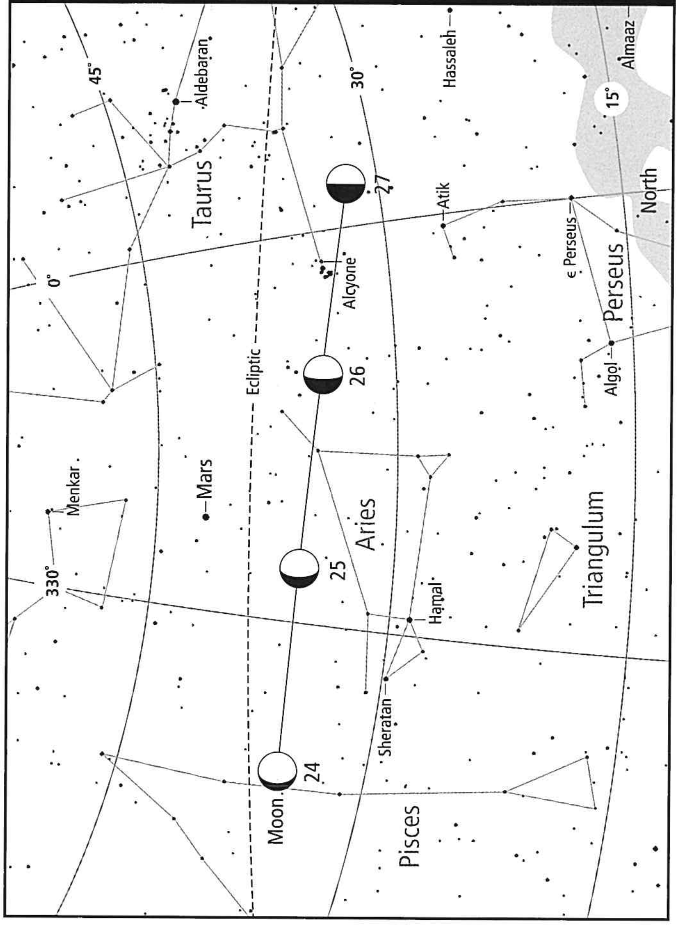
SATURN MOONS



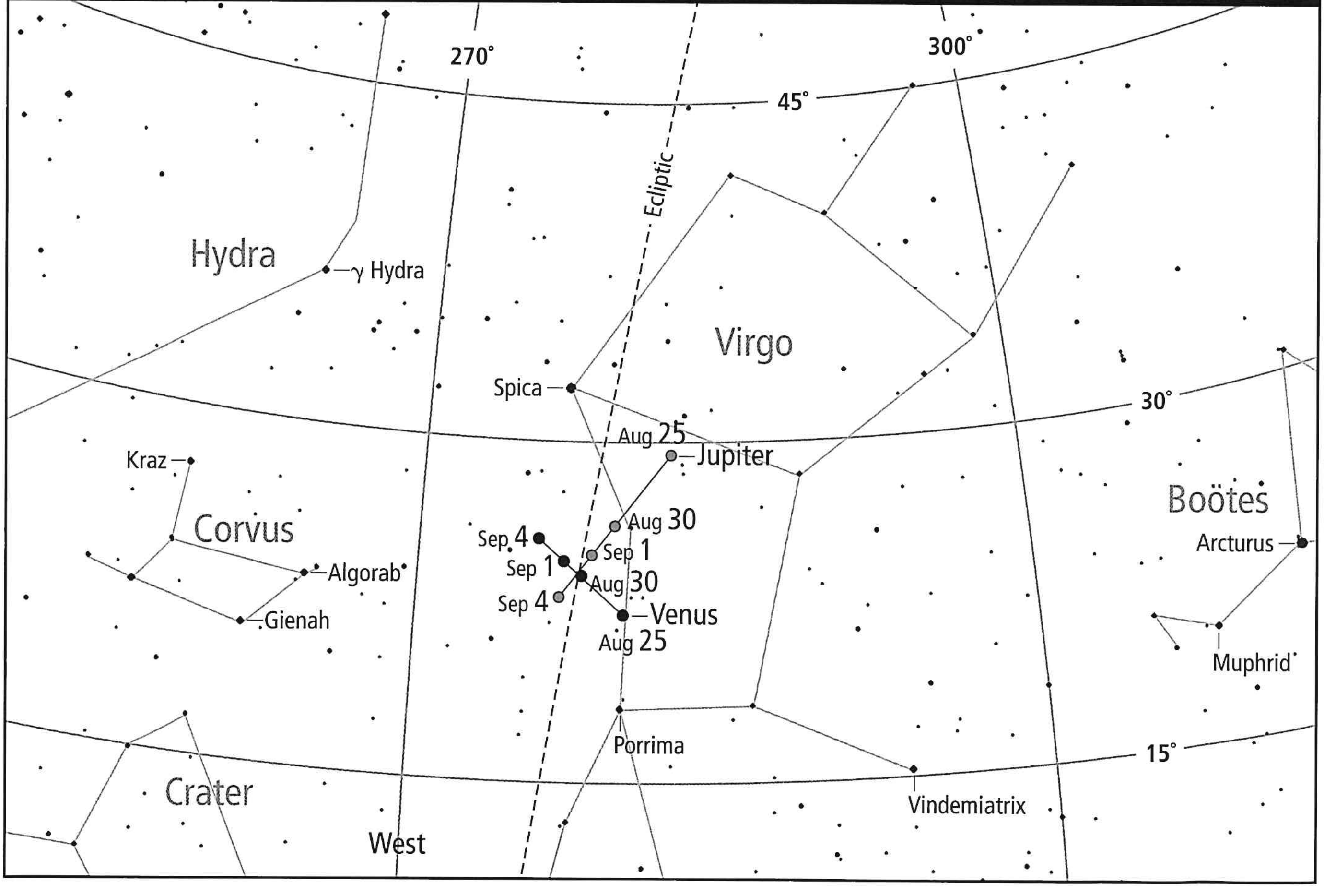
SKYVIEW 2005 AUGUST 7-11 6pm



SKYVIEW 2005 AUGUST 24-27 6am



SKYVIEW 2005 AUGUST 25 - SEPTEMBER 4 7pm



SEPTEMBER 2005

HIGHLIGHTS

***Mercury** visible in the evening in the second half of the month, low in west after twilight.*

***Venus** easily visible in the evening sky. Conjunction with Jupiter on 2nd.*

***Mars** rises in the evening.*

***Jupiter** visible in the early evening sky in constellation Virgo.*

***Saturn** visible before morning twilight in constellation Cancer.*

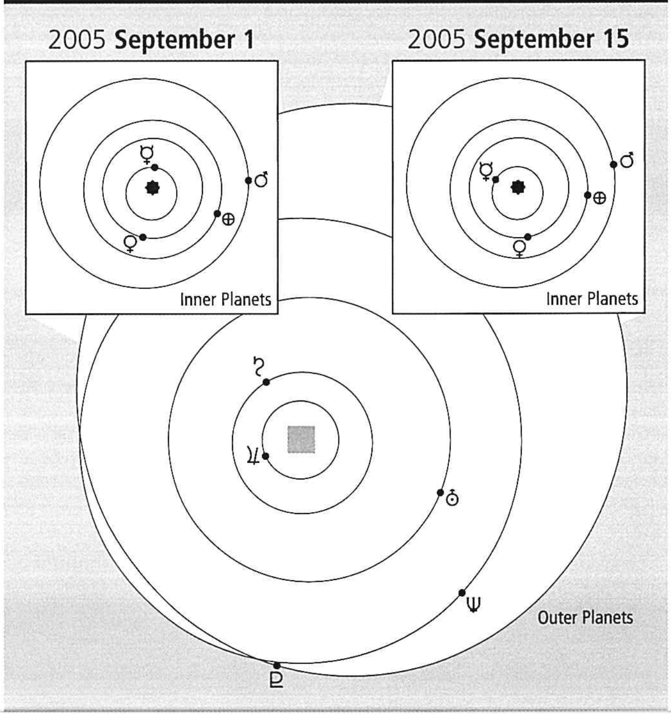
DIARY

Day	Hour	
1	01	Saturn 5° S. of Moon
1	11	Moon at apogee
2	20	Venus 1.°4 S. of Jupiter – Conjunction
3	11	Pluto stationary
4	03	**New Moon**
4	19	Mercury 1.°1 N. of Regulus
6	05	Venus 1.°8 N. of Spica
7	08	Jupiter 1.°8 N. of Moon
7	14	Spica 1.°3 S. of Moon
7	17	Venus 0.°6 N. of Moon
11	04	Antares 0.°2 S. of Moon
11	20	**First Quarter**
16	22	Moon at perigee
18	10	**Full Moon**
18	11	Mercury in superior conjunction
19		Maximum activity of Piscid meteor shower
22	06	Jupiter 3° N. of Spica
22	15	Mars 6° S. of Moon
23	06	Equinox
25	15	**Last Quarter**
28	13	Saturn 5° S. of Moon
28	23	Moon at apogee

SUN+MOON RISE/SET

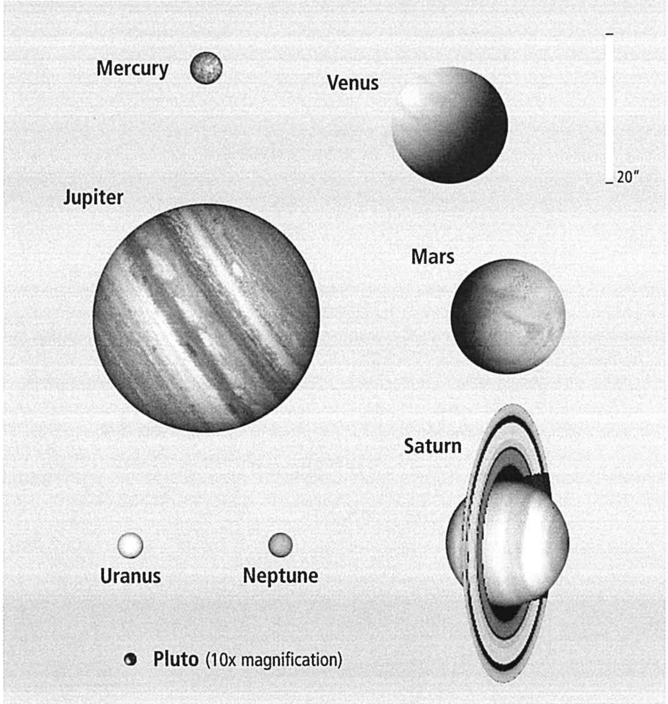
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0634	81	0513	1217	1800	279	1921	0521	1540	7
2	0633	81	0511	1216	1801	279	1922	0554	1637	3
3	0631	82	0510	1216	1801	278	1922	0623	1734	1
4	0630	82	0509	1216	1802	278	1923	0650	1830	0
5	0629	82	0508	1215	1802	277	1924	0715	1925	1
6	0627	83	0506	1215	1803	277	1924	0740	2021	5
7	0626	83	0505	1215	1804	277	1925	0806	2119	10
8	0625	84	0504	1214	1804	276	1925	0834	2220	16
9	0624	84	0503	1214	1805	276	1926	0906	2323	25
10	0622	85	0501	1214	1805	275	1927	0944	DNS	34
11	0621	85	0500	1213	1806	275	1927	1030	0029	45
12	0620	86	0459	1213	1807	274	1928	1124	0136	56
13	0618	86	0457	1213	1807	274	1928	1228	0239	67
14	0617	86	0456	1212	1808	273	1929	1339	0335	77
15	0616	87	0455	1212	1808	273	1930	1453	0425	87
16	0614	87	0453	1212	1809	272	1930	1607	0507	94
17	0613	88	0452	1211	1810	272	1931	1719	0543	98
18	0612	88	0451	1211	1810	272	1932	1829	0616	100
19	0610	89	0449	1210	1811	271	1932	1937	0647	99
20	0609	89	0448	1210	1811	271	1933	2044	0718	95
21	0608	90	0447	1210	1812	270	1934	2151	0751	89
22	0607	90	0445	1209	1813	270	1934	2257	0827	81
23	0605	91	0444	1209	1813	269	1935	DNR	0906	72
24	0604	91	0442	1209	1814	269	1936	0001	0951	63
25	0603	91	0441	1208	1815	268	1936	0100	1042	53
26	0601	92	0440	1208	1815	268	1937	0153	1136	43
27	0600	92	0438	1208	1816	267	1938	0240	1233	34
28	0559	93	0437	1207	1816	267	1939	0320	1332	25
29	0557	93	0435	1207	1817	267	1939	0355	1429	18
30	0556	94	0434	1207	1818	266	1940	0426	1526	11

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE



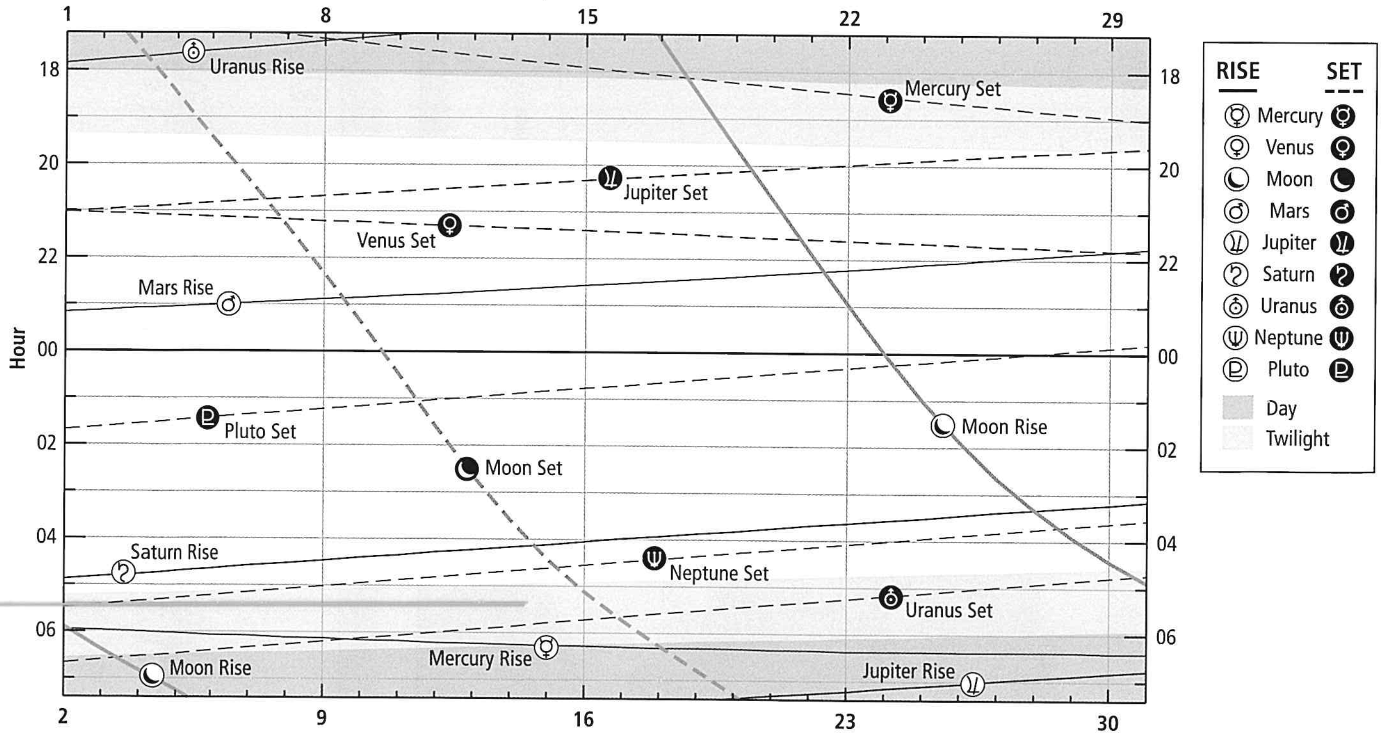
1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0555	1646	0820	2101	2310	1003	0827	2102	1	0456	1521	1751	0644	1602	0533	1219	0145
2	0557	1650	0819	2103	2308	1001	0824	2059	2	0453	1517	1747	0640	1558	0529	1215	0141
3	0558	1655	0818	2104	2305	0958	0820	2056	3	0449	1514	1743	0636	1554	0525	1211	0137
4	0600	1700	0817	2106	2303	0955	0817	2053	4	0446	1510	1739	0632	1550	0521	1207	0133
5	0602	1704	0816	2108	2301	0952	0814	2050	5	0442	1507	1735	0628	1546	0517	1204	0129
6	0604	1709	0815	2109	2258	0949	0810	2047	6	0439	1504	1731	0624	1542	0513	1200	0125
7	0605	1714	0814	2111	2256	0946	0807	2044	7	0435	1500	1727	0620	1537	0509	1156	0121
8	0607	1719	0814	2113	2253	0943	0803	2041	8	0432	1457	1722	0616	1533	0505	1152	0118
9	0608	1724	0813	2114	2251	0940	0800	2038	9	0428	1453	1718	0612	1529	0501	1148	0114
10	0610	1730	0812	2116	2248	0937	0757	2035	10	0424	1450	1714	0608	1525	0457	1144	0110
11	0611	1735	0811	2118	2246	0934	0753	2032	11	0421	1447	1710	0604	1521	0453	1140	0106
12	0613	1740	0810	2119	2243	0931	0750	2029	12	0417	1443	1706	0600	1517	0449	1136	0102
13	0614	1745	0809	2121	2240	0928	0746	2026	13	0414	1440	1702	0556	1513	0445	1132	0058
14	0615	1750	0808	2122	2237	0925	0743	2023	14	0410	1436	1658	0552	1509	0441	1128	0054
15	0616	1755	0808	2124	2234	0921	0740	2020	15	0407	1433	1654	0547	1505	0437	1124	0050
16	0617	1800	0807	2126	2232	0918	0736	2017	16	0403	1429	1649	0543	1501	0433	1120	0046
17	0618	1804	0806	2127	2229	0915	0733	2014	17	0359	1426	1645	0539	1457	0429	1116	0043
18	0619	1809	0805	2129	2226	0911	0729	2011	18	0356	1423	1641	0535	1453	0425	1112	0039
19	0619	1814	0805	2131	2223	0908	0726	2008	19	0352	1419	1637	0531	1449	0421	1109	0035
20	0620	1818	0804	2133	2219	0905	0723	2005	20	0349	1416	1633	0527	1445	0417	1105	0031
21	0621	1823	0803	2134	2216	0901	0719	2002	21	0345	1412	1629	0523	1441	0413	1101	0027
22	0621	1827	0803	2136	2213	0858	0716	1959	22	0341	1409	1625	0519	1437	0409	1057	0023
23	0622	1832	0802	2138	2210	0854	0713	1956	23	0338	1405	1621	0515	1433	0405	1053	0019
24	0622	1836	0801	2139	2206	0850	0709	1953	24	0334	1402	1617	0511	1429	0401	1049	0015
25	0622	1840	0801	2141	2203	0847	0706	1950	25	0331	1358	1613	0507	1425	0357	1045	0012
26	0623	1844	0800	2143	2159	0843	0703	1947	26	0327	1355	1608	0503	1421	0353	1041	0008
27	0623	1849	0800	2144	2156	0839	0659	1944	27	0323	1351	1604	0459	1417	0349	1037	0004
28									27								0000
28	0623	1853	0759	2146	2152	0836	0656	1942	28	0320	1348	1600	0455	1413	0345	1033	2356
29	0623	1857	0759	2148	2149	0832	0653	1939	29	0316	1344	1556	0451	1409	0341	1029	2352
30	0624	1901	0758	2149	2145	0828	0649	1936	30	0313	1341	1552	0447	1405	0337	1026	2348

SOLAR SYSTEM RISE/SET

September 2005



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Satellite	Event	DAY	PHENOMENON h m	Satellite	Event
1	1919	I	Tr.E.	11	2059		GRS
1	2006	I	Sh.E.	12	2010	II	Ec.R.
2	1825	III	Sh.I.	16	1209		GRS
2	2040	III	Sh.E.	16	1829	I	Oc.D.
3	1910	II	Tr.I.	17	1824	I	Sh.E.
3	2046	II	Sh.I.	19	1901	II	Oc.D.
4	2010		GRS	20	1850	III	Ec.R.
8	1907	I	Tr.I.	21	1919		GRS
8	1950	I	Sh.I.	24	1951	I	Tr.E.
9	1920		GRS	27	1845	III	Oc.D.
9	1922	I	Ec.R.	28	1209		GRS
9	1926	III	Tr.I.	28	1942	II	Tr.E.

Moons:

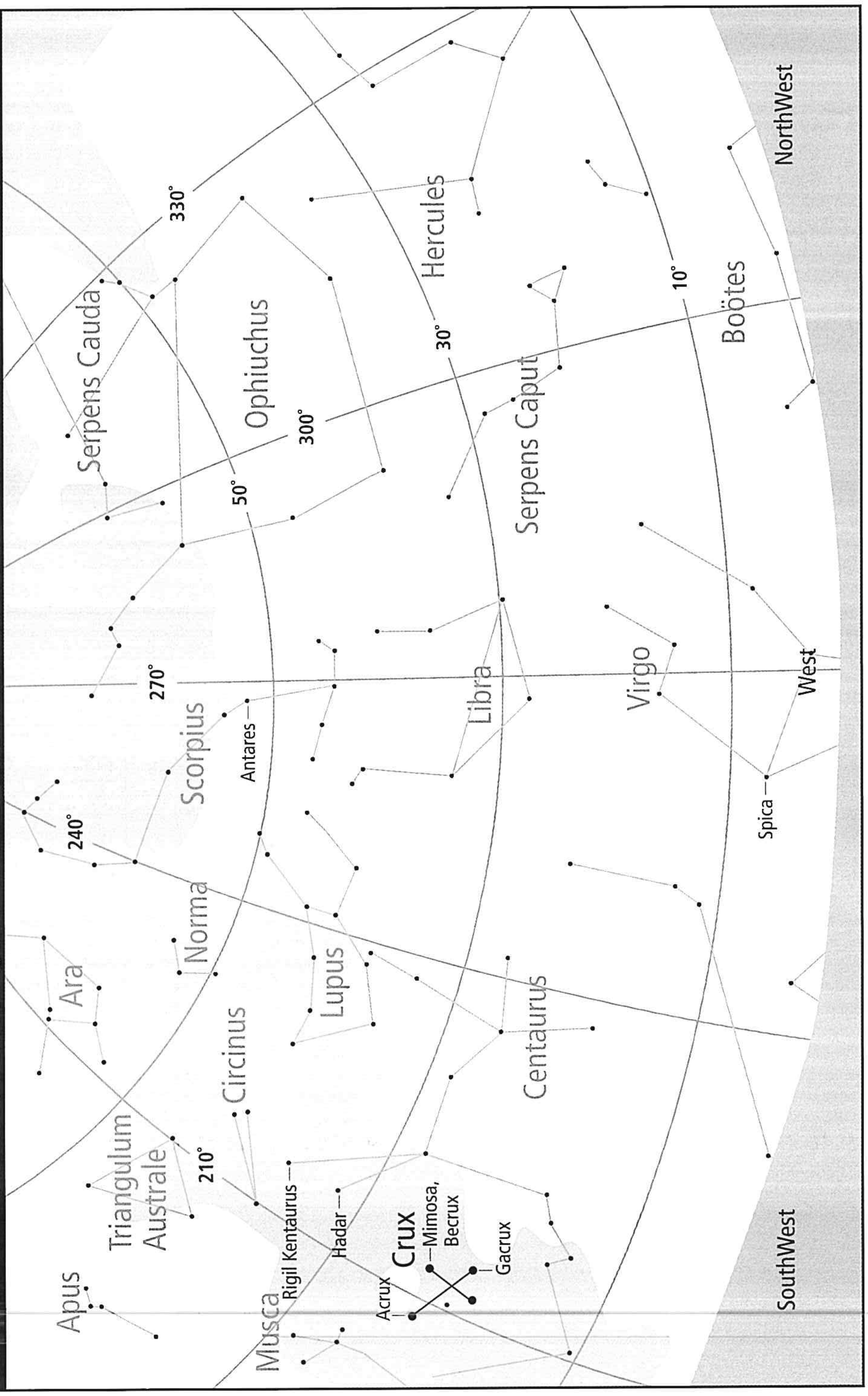
I	Io	III	Ganymede
II	Europa	IV	Callisto

Events:

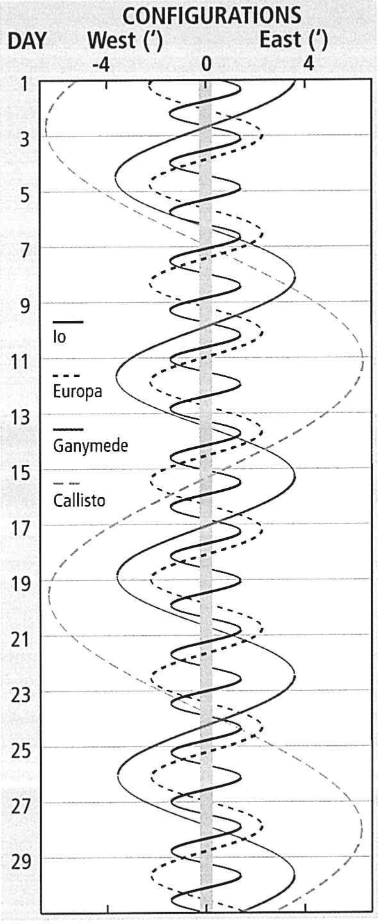
D	Disappear	R	Reappear
E	Egress	I	Ingress
Ec	Eclipse	Oc	Occult
Sh	Shadow	Tr	Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

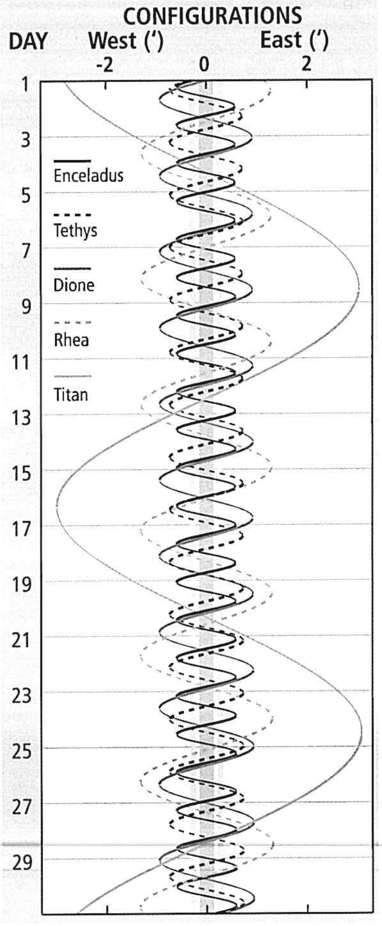
SKYVIEW SEPTEMBER 15 8pm – LOOKING WEST (and SOUTHERN CROSS)



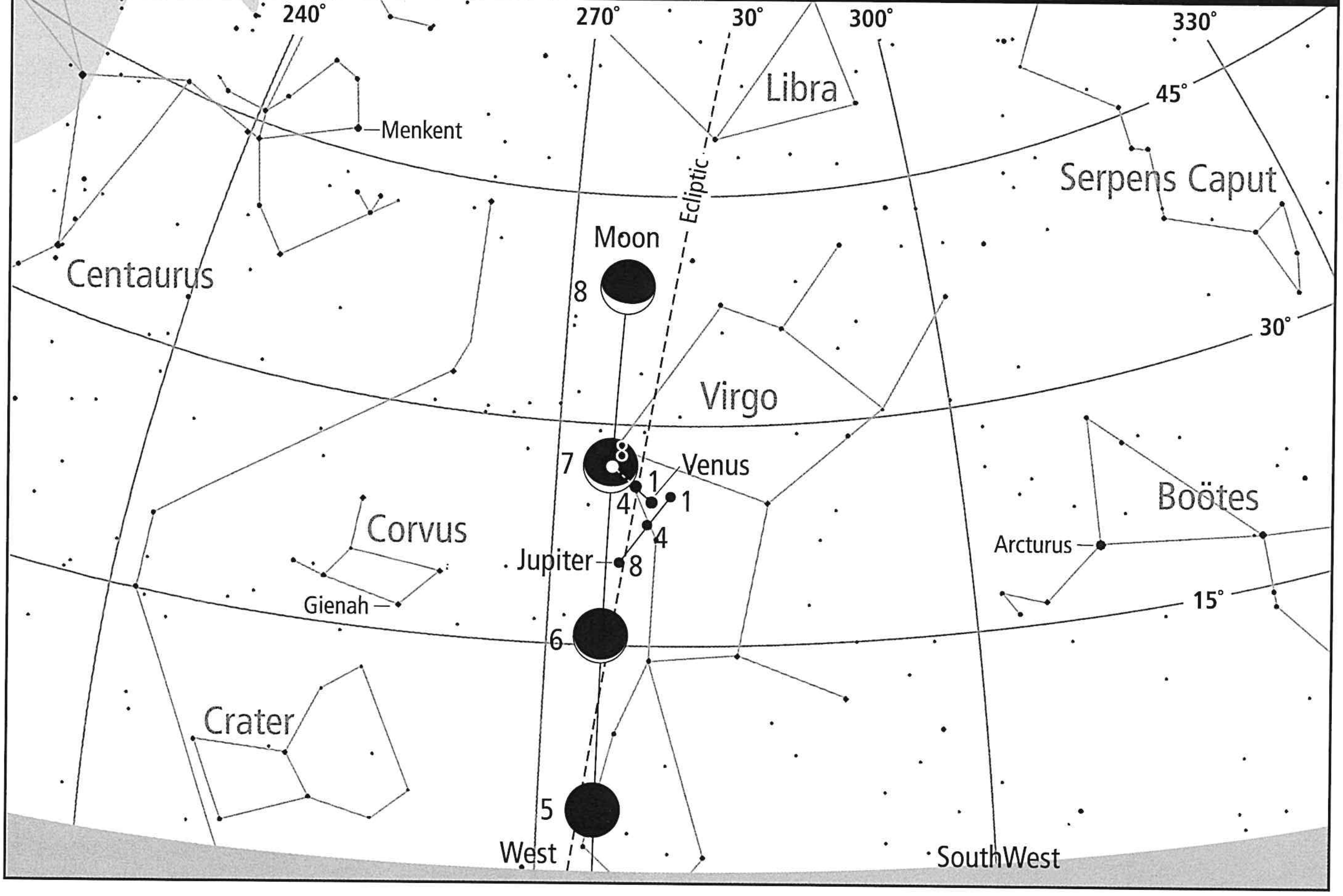
JUPITER MOONS



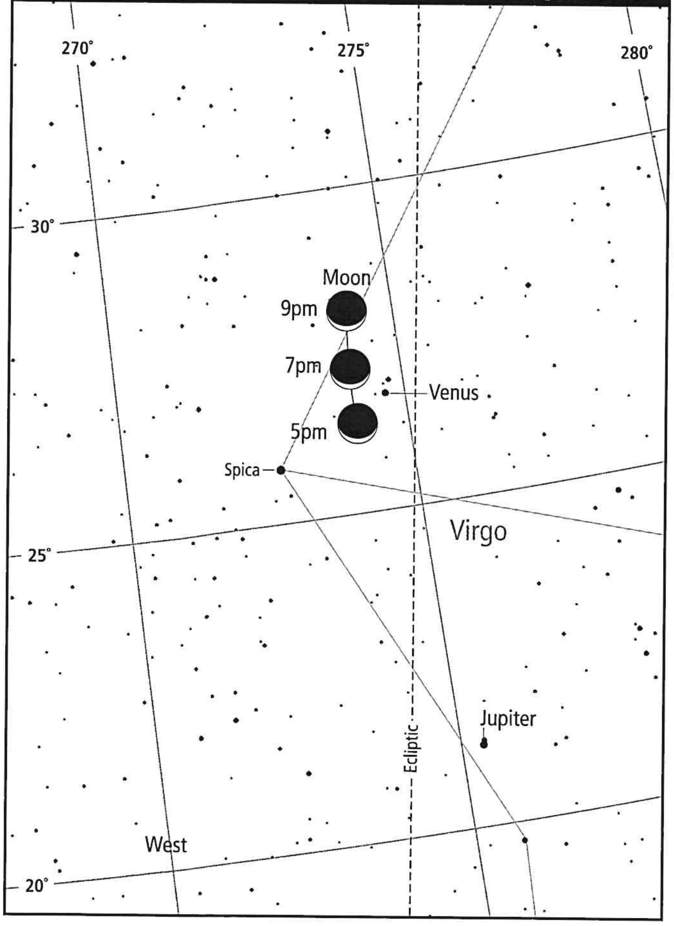
SATURN MOONS



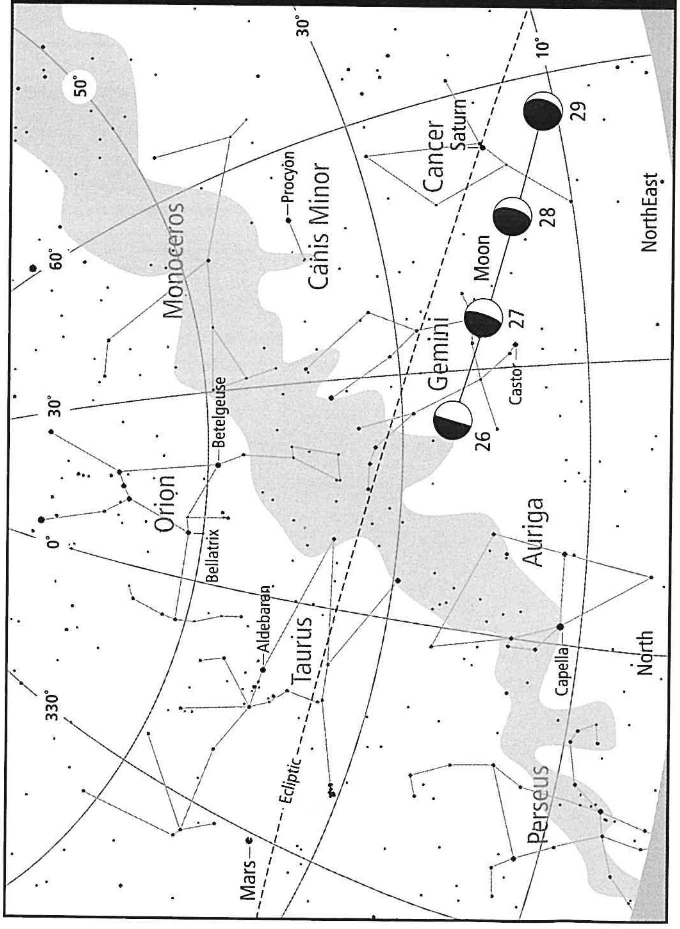
SKYVIEW 2005 SEPTEMBER 1-8 7pm



SKYVIEW 2005 SEPTEMBER 7 5-9pm



SKYVIEW 2005 SEPTEMBER 26-29 5am



OCTOBER 2005

HIGHLIGHTS

Moon *partial eclipse 17th*

Mercury *visible in the evenings, low in the west after civil twilight. Conjunction with Jupiter on 6th.*

Venus *easily visible in the evening sky. On 7th Venus may be visible to the unaided eye close to the Moon (****Do NOT look at the Sun****).*

Mars *rises in the evening in the constellation Aries.*

Saturn *visible in the morning in Cancer.*

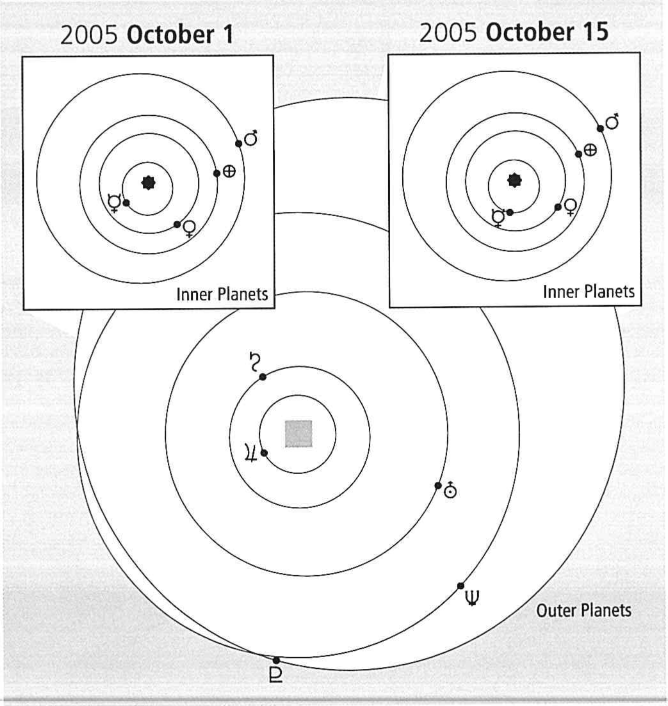
DIARY

Day	Hour	
1	18	Mars stationary
3	18	**New Moon**
4	16	Mercury 2.° N. of Spica
6	15	Mercury 1.°5 S. of Jupiter – Conjunction
7	14	Venus 1.°4 N. of Moon
8	09	Antares 0.°2 S. of Moon
11	03	**First Quarter**
14	22	Moon at perigee
17	02	Venus 1.°6 N. of Antares
17	20	**Full Moon – Partial Eclipse of the Moon**
18		Maximum activity of epsilon-Geminid meteor shower
19	21	Mars 5° S. of Moon
22		Maximum activity of epsilon-Orionid meteor shower
22	21	Jupiter in conjunction with Sun
25	09	**Last Quarter**
26	01	Saturn 4° S. of Moon
26	18	Moon at apogee
30	11	Mars closest approach

SUN+MOON RISE/SET

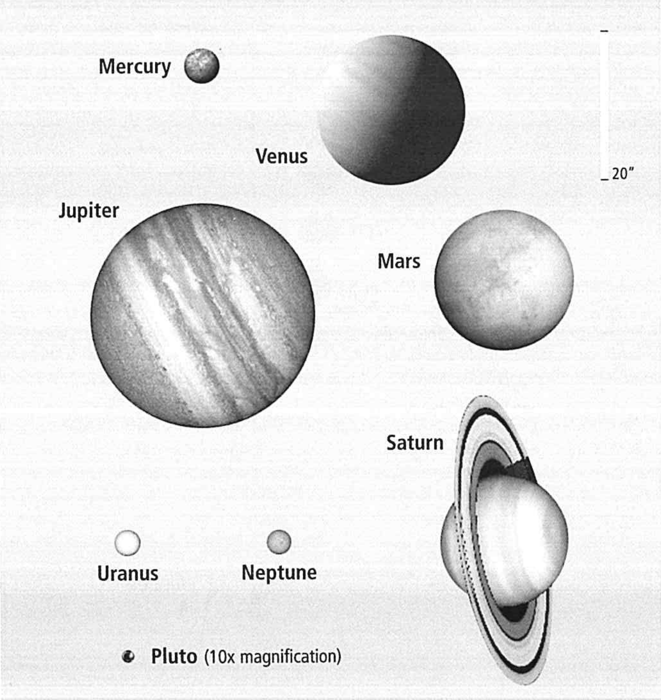
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0555	94	0433	1206	1818	266	1941	0453	1622	6
2	0553	95	0431	1206	1819	265	1942	0519	1718	2
3	0552	95	0430	1206	1820	265	1942	0544	1815	0
4	0551	96	0428	1205	1820	264	1943	0610	1913	0
5	0550	96	0427	1205	1821	264	1944	0637	2013	3
6	0548	96	0425	1205	1822	263	1945	0708	2117	7
7	0547	97	0424	1204	1822	263	1946	0745	2222	13
8	0546	97	0423	1204	1823	262	1946	0827	2328	21
9	0545	98	0421	1204	1824	262	1947	0919	DNS	31
10	0543	98	0420	1204	1825	261	1948	1019	0032	41
11	0542	99	0418	1203	1825	261	1949	1126	0130	53
12	0541	99	0417	1203	1826	261	1950	1237	0220	64
13	0540	100	0416	1203	1827	260	1951	1348	0303	75
14	0538	100	0414	1203	1827	260	1952	1459	0340	84
15	0537	100	0413	1202	1828	259	1953	1608	0413	92
16	0536	101	0411	1202	1829	259	1954	1715	0444	97
17	0535	101	0410	1202	1830	258	1955	1822	0515	100
18	0534	102	0409	1202	1830	258	1956	1930	0546	100
19	0533	102	0407	1202	1831	258	1957	2037	0620	97
20	0532	103	0406	1201	1832	257	1958	2143	0659	93
21	0530	103	0405	1201	1833	257	1959	2246	0742	86
22	0529	103	0403	1201	1833	256	2000	2344	0831	78
23	0528	104	0402	1201	1834	256	2001	DNR	0925	69
24	0527	104	0401	1201	1835	255	2002	0034	1022	60
25	0526	105	0359	1201	1836	255	2003	0117	1121	51
26	0525	105	0358	1201	1837	255	2004	0154	1219	41
27	0524	106	0357	1200	1837	254	2005	0226	1316	32
28	0523	106	0356	1200	1838	254	2006	0255	1412	24
29	0522	106	0354	1200	1839	253	2007	0321	1508	16
30	0521	107	0353	1200	1840	253	2008	0346	1604	10
31	0520	107	0352	1200	1841	253	2009	0412	1702	5

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

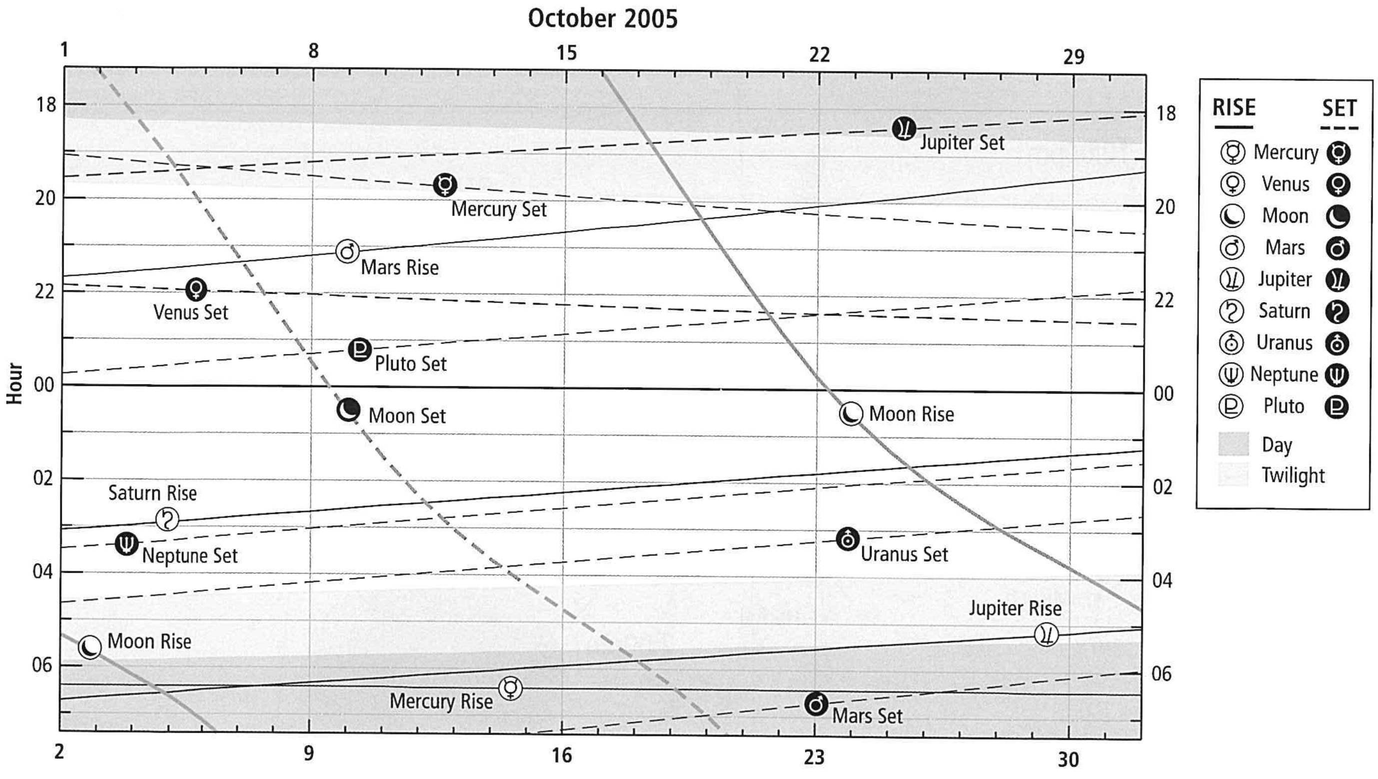


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0624	1904	0758	2151	2141	0824	0646	1933	1	0309	1337	1548	0443	1401	0333	1022	2345
2	0624	1908	0757	2153	2137	0820	0643	1930	2	0305	1334	1544	0439	1357	0329	1018	2341
3	0624	1912	0757	2154	2133	0816	0639	1927	3	0302	1330	1540	0435	1353	0325	1014	2337
4	0624	1916	0757	2156	2129	0812	0636	1924	4	0258	1327	1536	0431	1349	0322	1010	2333
5	0624	1919	0756	2158	2125	0807	0633	1921	5	0254	1323	1532	0427	1345	0318	1006	2329
6	0624	1923	0756	2159	2121	0803	0629	1918	6	0251	1319	1528	0423	1341	0314	1002	2325
7	0624	1927	0756	2201	2117	0759	0626	1915	7	0247	1316	1524	0419	1337	0310	0958	2321
8	0624	1930	0755	2202	2112	0755	0623	1912	8	0243	1312	1519	0415	1333	0306	0955	2318
9	0624	1934	0755	2204	2108	0750	0619	1909	9	0240	1309	1515	0411	1329	0302	0951	2314
10	0624	1937	0755	2206	2103	0746	0616	1906	10	0236	1305	1511	0407	1325	0258	0947	2310
11	0624	1940	0755	2207	2059	0741	0613	1903	11	0232	1302	1507	0403	1321	0254	0943	2306
12	0625	1944	0755	2209	2054	0737	0609	1901	12	0229	1258	1503	0359	1317	0250	0939	2302
13	0625	1947	0755	2210	2050	0732	0606	1858	13	0225	1254	1459	0355	1313	0246	0935	2258
14	0625	1950	0755	2212	2045	0727	0603	1855	14	0221	1251	1455	0351	1309	0242	0931	2255
15	0625	1954	0755	2213	2040	0723	0559	1852	15	0218	1247	1451	0347	1305	0238	0927	2251
16	0625	1957	0755	2215	2035	0718	0556	1849	16	0214	1244	1447	0343	1301	0234	0924	2247
17	0625	2000	0755	2216	2031	0713	0553	1846	17	0210	1240	1443	0339	1257	0230	0920	2243
18	0625	2003	0755	2218	2026	0708	0549	1843	18	0206	1236	1439	0335	1253	0226	0916	2239
19	0625	2006	0755	2219	2021	0703	0546	1840	19	0203	1233	1435	0331	1249	0222	0912	2236
20	0625	2009	0755	2220	2016	0658	0543	1837	20	0159	1229	1431	0327	1245	0218	0908	2232
21	0625	2012	0755	2222	2010	0653	0539	1834	21	0155	1225	1427	0323	1242	0214	0904	2228
22	0626	2015	0755	2223	2005	0648	0536	1831	22	0151	1222	1423	0319	1238	0210	0900	2224
23	0626	2018	0756	2224	2000	0643	0533	1829	23	0148	1218	1419	0315	1234	0206	0857	2220
24	0626	2020	0756	2225	1955	0638	0529	1826	24	0144	1214	1415	0311	1230	0202	0853	2216
25	0626	2023	0756	2226	1950	0633	0526	1823	25	0140	1211	1411	0307	1226	0158	0849	2213
26	0626	2026	0756	2227	1944	0628	0523	1820	26	0136	1207	1407	0303	1222	0155	0845	2209
27	0626	2028	0757	2228	1939	0623	0520	1817	27	0133	1203	1403	0259	1218	0151	0841	2205
28	0626	2030	0757	2229	1933	0618	0516	1814	28	0129	1200	1359	0255	1214	0147	0837	2201
29	0627	2032	0757	2230	1928	0612	0513	1811	29	0125	1156	1355	0251	1210	0143	0834	2157
30	0627	2034	0758	2231	1923	0607	0510	1808	30	0121	1152	1351	0247	1206	0139	0830	2154
31	0627	2036	0758	2232	1917	0602	0506	1805	31	0118	1148	1347	0243	1202	0135	0826	2150

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON			
	h m	Satellite	Event	
3	1856		GRS	Great Red Spot
9	1903	I	Oc.D.	Occult Disappear
10	1835	I	Sh.E.	Shadow Egress
15	1856		GRS	Great Red Spot

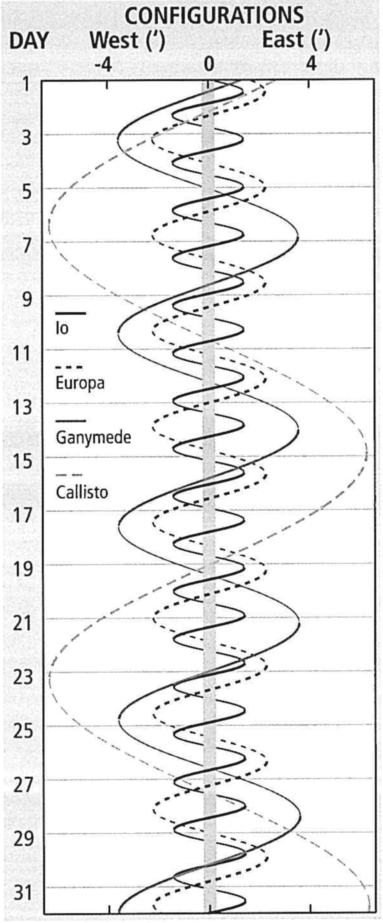
Astro Fact – Jupiter's Great Red Spot

Jupiter's Red Spot is about 20,000 km long (about 1.5 times the diameter of Earth) and has been studied since the telescope was invented 300 years ago. It is defined as a high-pressure cyclonic storm (unlike Earth's cyclones, which are low-pressure zones). The Red Spot rotates once counter-clockwise every 6 days and winds in its outer regions reach 350km/h while those at its centre are much lower. Trace amounts of organic molecules composed of hydrogen and carbon atoms, and possibly sulphur and phosphorus atoms, give the Red Spot and other features of the Jovian atmosphere their distinct colours.

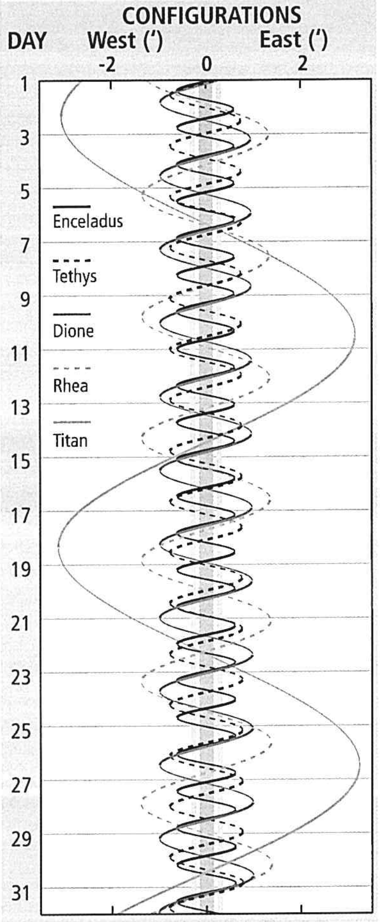
Predicting the visibility times of the Red Spot is a little difficult because:

- Its position slowly varies with time owing to the variable drag it experiences in the Jovian atmosphere, and
- Jupiter doesn't rotate as a solid object; clouds near the equator rotate a little faster than those closer to the poles.

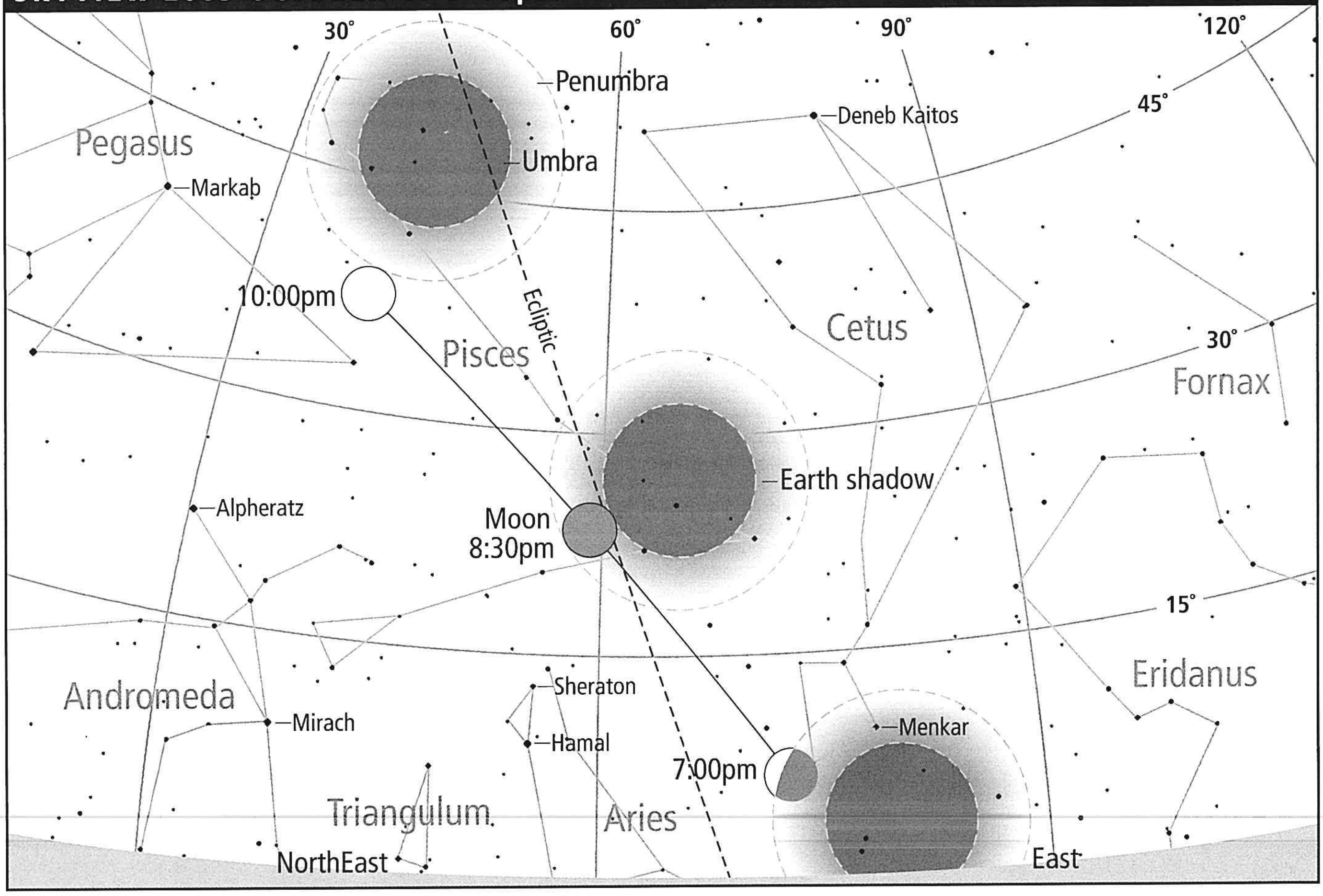
JUPITER MOONS

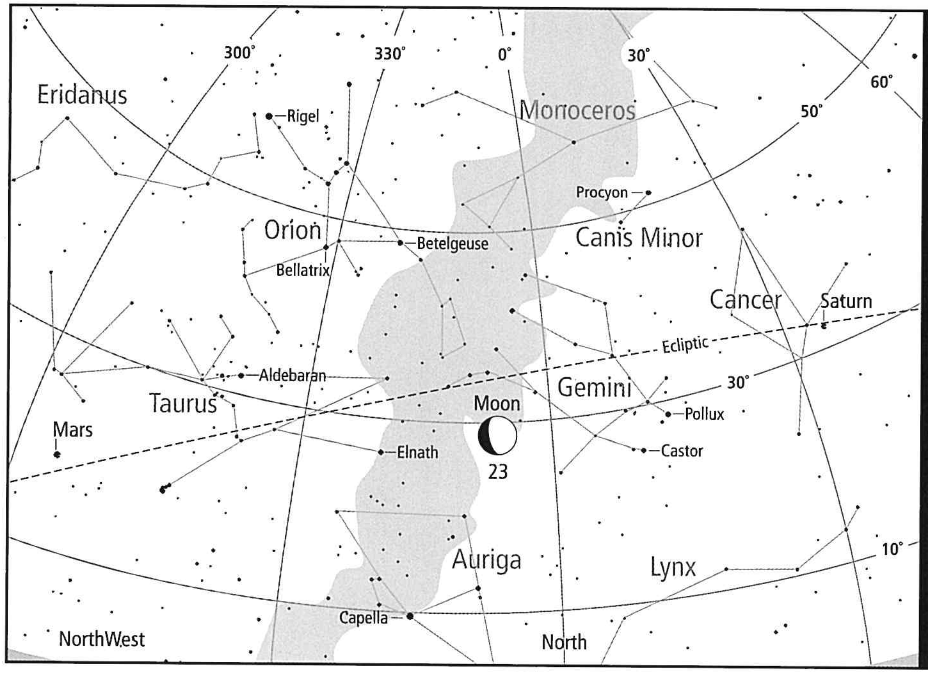


SATURN MOONS

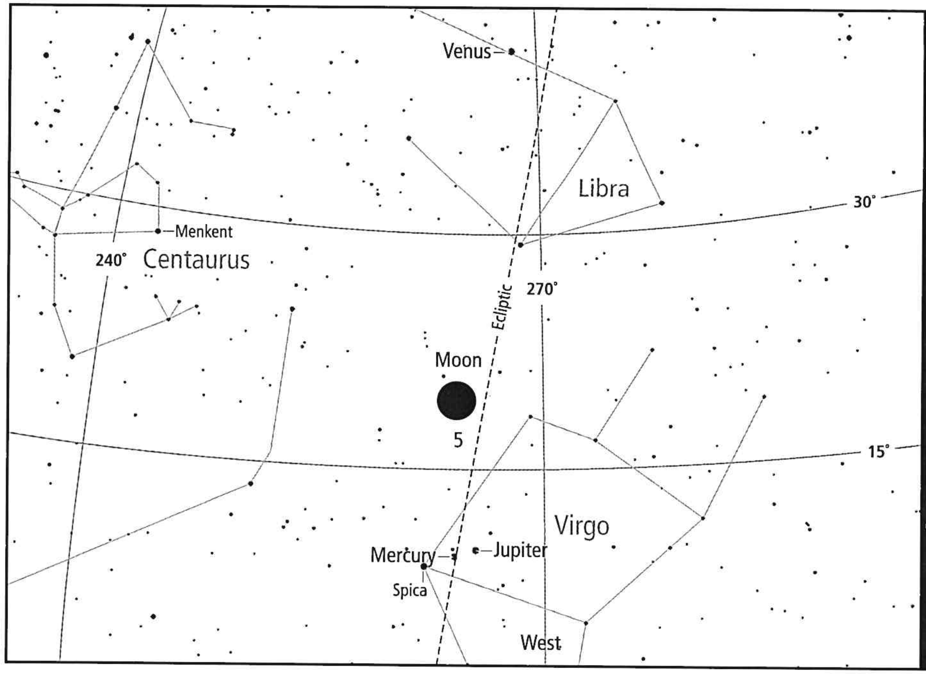


SKYVIEW 2005 OCTOBER 17 7-10pm

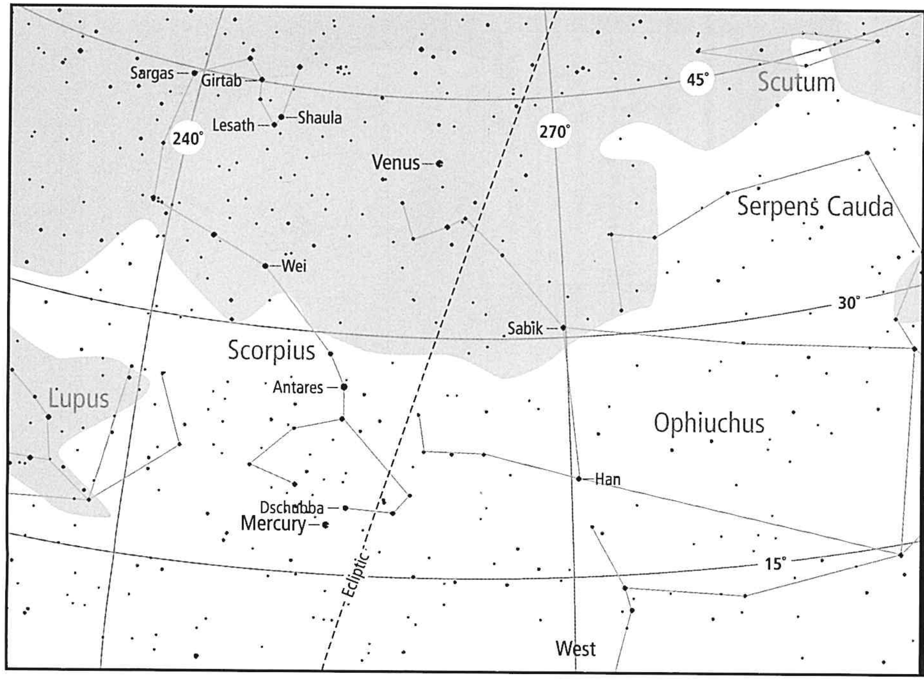




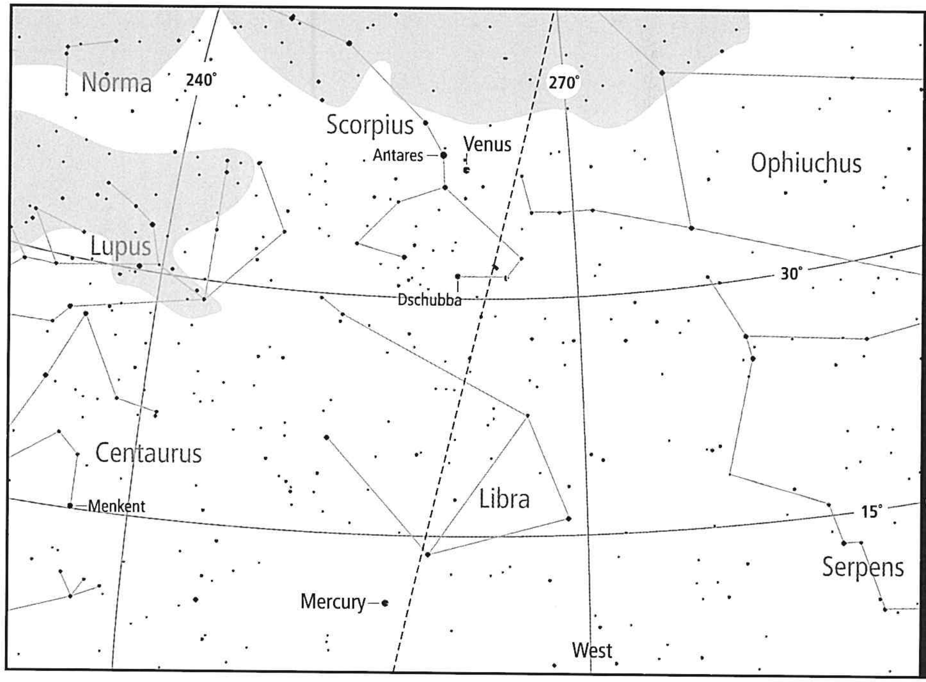
SKYVIEW 2005 OCTOBER 23 5am



SKYVIEW 2005 OCTOBER 5 6.30pm



SKYVIEW 2005 OCTOBER 31 7pm



SKYVIEW 2005 OCTOBER 16 7pm

NOVEMBER 2005

HIGHLIGHTS

***Mercury** visible in the evenings, first half of the month, low in the west after civil twilight.*

***Venus** easily visible in the evening sky.*

***Mars** at opposition and visible all night in the constellation Aries.*

***Jupiter** rises in morning twilight in Virgo.*

***Saturn** rises around midnight in Cancer.*

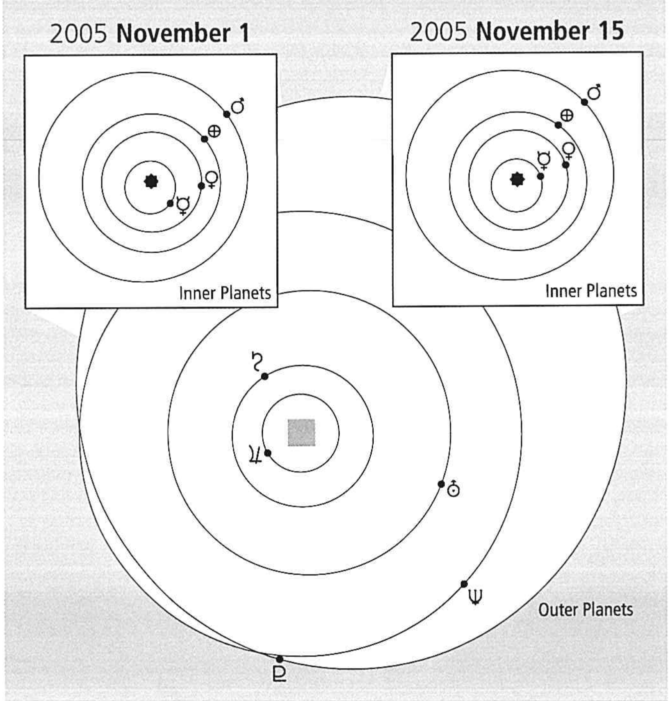
DIARY

Day	Hour	
1	03	Spica 1.°2 S. of Moon
2	09	**New Moon**
4	00	Mercury greatest elongation E. (24°)
4	03	Venus greatest elongation E. (47°)
4	07	Mercury 1.°3 N. of Moon
4	15	Antares 0.°2 S. of Moon – Occultation visible from northern Australia
5		Max activity of Southern Taurid meteor s.
6	03	Venus 1.°4 N. of Moon
7	16	Mars at opposition
9	10	**First Quarter**
10	00	Mercury 1.°9 N. of Antares
10	08	Moon at perigee
12		Max activity of Northern Taurid meteor s.
14	17	Mercury stationary
15	14	Mars 3° S. of Moon
16	09	**Full Moon**
17		Max activity of Leonid meteor shower
19	00	Mercury 3.° N. of Antares
21		Max activity of alpha-Monocerotid meteor s.
22	11	Saturn 4° S. of Moon
23	02	Saturn stationary
23	14	Moon at apogee
24	06	**Last Quarter**
25	00	Mercury in inferior conjunction
28	12	Spica 1.°1 S. of Moon
29	16	Jupiter 3° N. of Moon

SUN+MOON RISE/SET

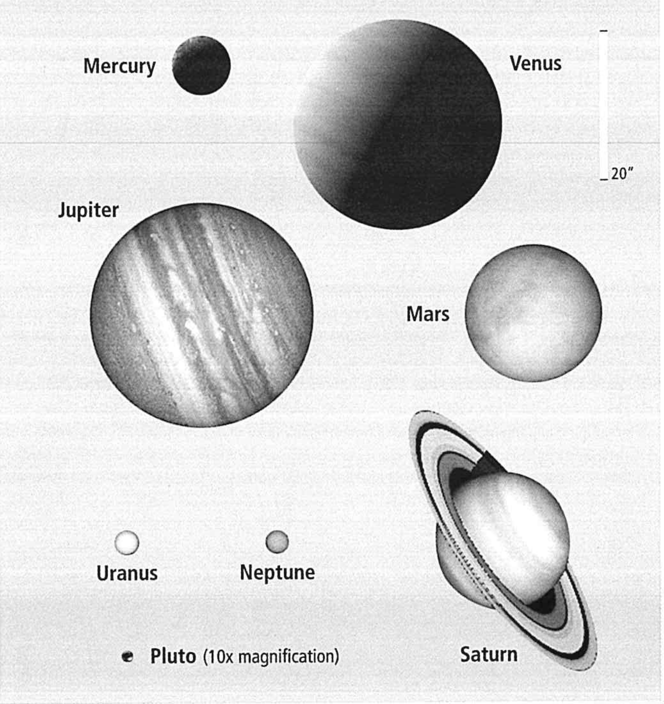
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0519	108	0351	1200	1842	252	2010	0439	1802	1
2	0518	108	0350	1200	1842	252	2012	0509	1905	0
3	0518	108	0348	1200	1843	251	2013	0544	2012	1
4	0517	109	0347	1200	1844	251	2014	0625	2119	5
5	0516	109	0346	1200	1845	251	2015	0714	2225	10
6	0515	109	0345	1200	1846	250	2016	0812	2325	18
7	0514	110	0344	1200	1847	250	2017	0918	DNS	27
8	0514	110	0343	1200	1848	250	2019	1028	0018	38
9	0513	110	0342	1200	1848	249	2020	1138	0102	49
10	0512	111	0341	1201	1849	249	2021	1248	0140	61
11	0511	111	0340	1201	1850	249	2022	1355	0214	71
12	0511	111	0339	1201	1851	248	2023	1500	0244	81
13	0510	112	0338	1201	1852	248	2025	1606	0314	89
14	0510	112	0337	1201	1853	248	2026	1711	0344	95
15	0509	112	0336	1201	1854	247	2027	1818	0417	99
16	0508	113	0335	1201	1855	247	2028	1925	0453	100
17	0508	113	0334	1202	1856	247	2029	2029	0533	99
18	0507	113	0334	1202	1857	247	2031	2130	0620	96
19	0507	114	0333	1202	1857	246	2032	2224	0713	91
20	0506	114	0332	1202	1858	246	2033	2311	0809	84
21	0506	114	0331	1202	1859	246	2034	2351	0908	76
22	0506	114	0331	1203	1900	245	2035	DNR	1007	68
23	0505	115	0330	1203	1901	245	2037	0025	1105	59
24	0505	115	0329	1203	1902	245	2038	0055	1201	49
25	0505	115	0329	1204	1903	245	2039	0121	1256	40
26	0504	115	0328	1204	1904	244	2040	0147	1352	31
27	0504	116	0328	1204	1905	244	2041	0212	1448	22
28	0504	116	0327	1204	1905	244	2042	0238	1547	15
29	0504	116	0327	1205	1906	244	2043	0307	1649	8
30	0504	116	0326	1205	1907	244	2045	0339	1754	3

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ♅ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

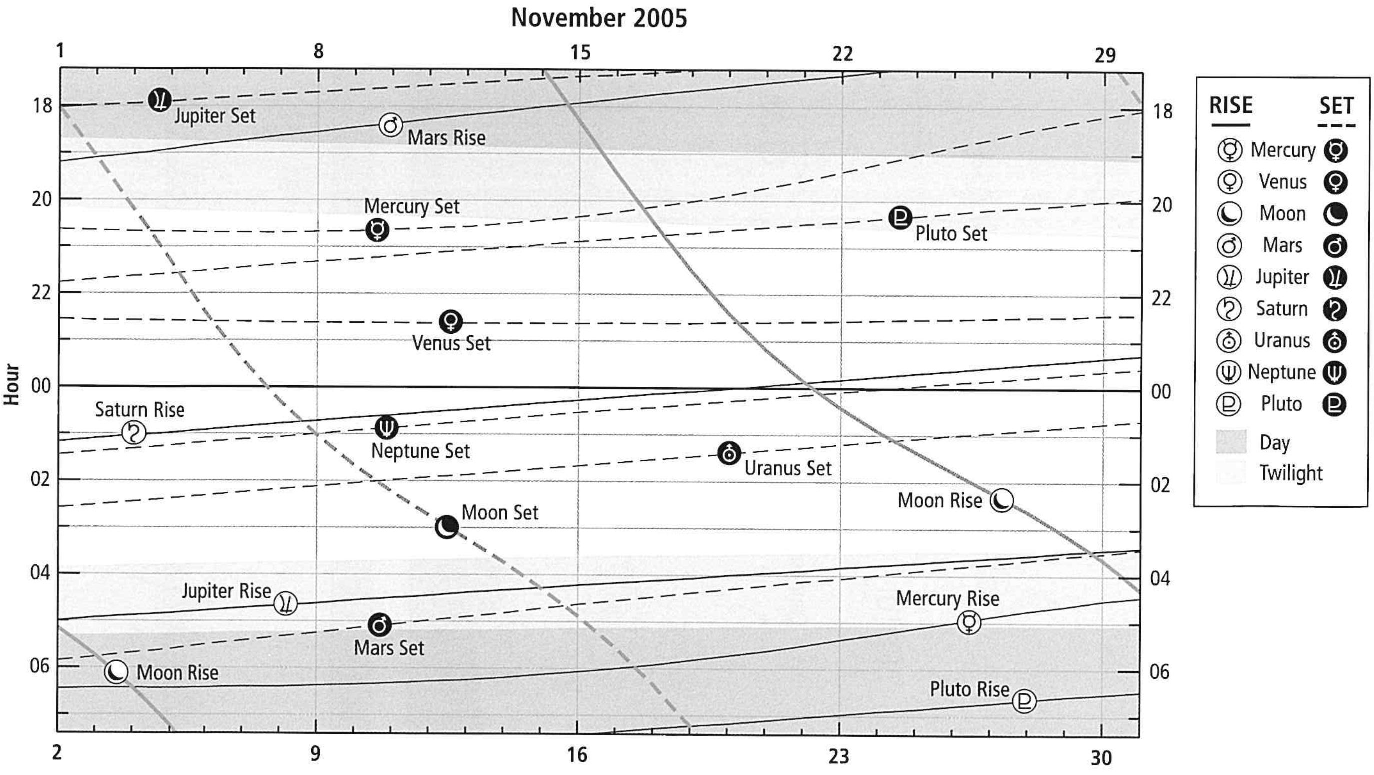


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0627	2038	0759	2233	1912	0557	0503	1802	1	0114	1145	1343	0239	1158	0131	0822	2146
2	0627	2039	0759	2234	1906	0551	0500	1759	2	0110	1141	1339	0235	1154	0127	0818	2142
3	0626	2040	0759	2234	1901	0546	0456	1757	3	0106	1137	1335	0231	1150	0123	0814	2138
4	0626	2041	0800	2235	1855	0541	0453	1754	4	0102	1133	1331	0227	1147	0119	0811	2135
5	0626	2042	0800	2236	1849	0536	0450	1751	5	0059	1130	1327	0223	1143	0115	0807	2131
6	0625	2042	0801	2236	1844	0530	0447	1748	6	0055	1126	1323	0219	1139	0111	0803	2127
7	0624	2042	0801	2237	1838	0525	0443	1745	7	0051	1122	1319	0215	1135	0107	0759	2123
8	0624	2041	0802	2237	1833	0520	0440	1742	8	0047	1118	1315	0211	1131	0104	0755	2119
9	0622	2040	0802	2237	1827	0515	0437	1739	9	0043	1114	1311	0207	1127	0100	0751	2116
10	0621	2038	0803	2237	1822	0509	0433	1736	10	0039	1111	1307	0203	1123	0056	0748	2112
11	0619	2036	0803	2238	1816	0504	0430	1733	11	0036	1107	1303	0159	1119	0052	0744	2108
12	0617	2034	0803	2238	1811	0459	0427	1730	12	0032	1103	1259	0155	1115	0048	0740	2104
13	0615	2030	0804	2238	1806	0454	0423	1727	13	0028	1059	1255	0152	1111	0044	0736	2101
14	0612	2026	0804	2238	1800	0449	0420	1724	14	0024	1055	1251	0148	1108	0040	0732	2057
15	0608	2021	0805	2238	1755	0443	0417	1721	15	0020	1051	1247	0144	1104	0036	0729	2053
16	0604	2015	0805	2237	1750	0438	0413	1719	16	0016	1047	1243	0140	1100	0032	0725	2049
17	0600	2008	0805	2237	1744	0433	0410	1716	17	0012	1044	1239	0136	1056	0028	0721	2045
18	0555	2001	0806	2237	1739	0428	0407	1713	18	0008	1040	1236	0132	1052	0025	0717	2042
19	0549	1953	0806	2236	1734	0423	0404	1710	19	0005	1036	1232	0128	1048	0021	0713	2038
20	0543	1943	0806	2236	1729	0418	0400	1707	20	0001	1032	1228	0124	1044	0017	0710	2034
20									20	2357							
21	0537	1934	0806	2235	1724	0413	0357	1704	21	2353	1028	1224	0120	1040	0013	0706	2030
22	0530	1923	0807	2234	1719	0408	0354	1701	22	2349	1024	1220	0116	1037	0009	0702	2027
23	0522	1912	0807	2233	1714	0404	0350	1658	23	2345	1020	1216	0112	1033	0005	0658	2023
24	0515	1901	0807	2232	1709	0359	0347	1655	24	2341	1016	1212	0108	1029	0001	0654	2019
24									24						2357		
25	0507	1850	0807	2231	1704	0354	0344	1652	25	2337	1012	1208	0104	1025	2353	0651	2015
26	0500	1840	0807	2230	1659	0349	0340	1649	26	2333	1008	1204	0100	1021	2350	0647	2011
27	0452	1829	0807	2229	1654	0345	0337	1646	27	2329	1004	1200	0057	1017	2346	0643	2008
28	0445	1820	0807	2228	1650	0340	0334	1643	28	2325	1000	1156	0053	1013	2342	0639	2004
29	0439	1811	0806	2226	1645	0335	0330	1640	29	2321	0956	1153	0049	1010	2338	0635	2000
30	0432	1803	0806	2225	1640	0331	0327	1637	30	2317	0952	1149	0045	1006	2334	0632	1956

SOLAR SYSTEM RISE/SET

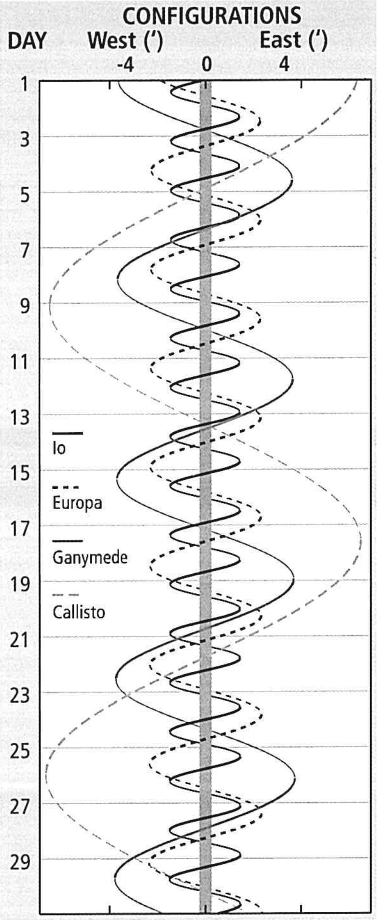


JUPITER MOONS + GREAT RED SPOT

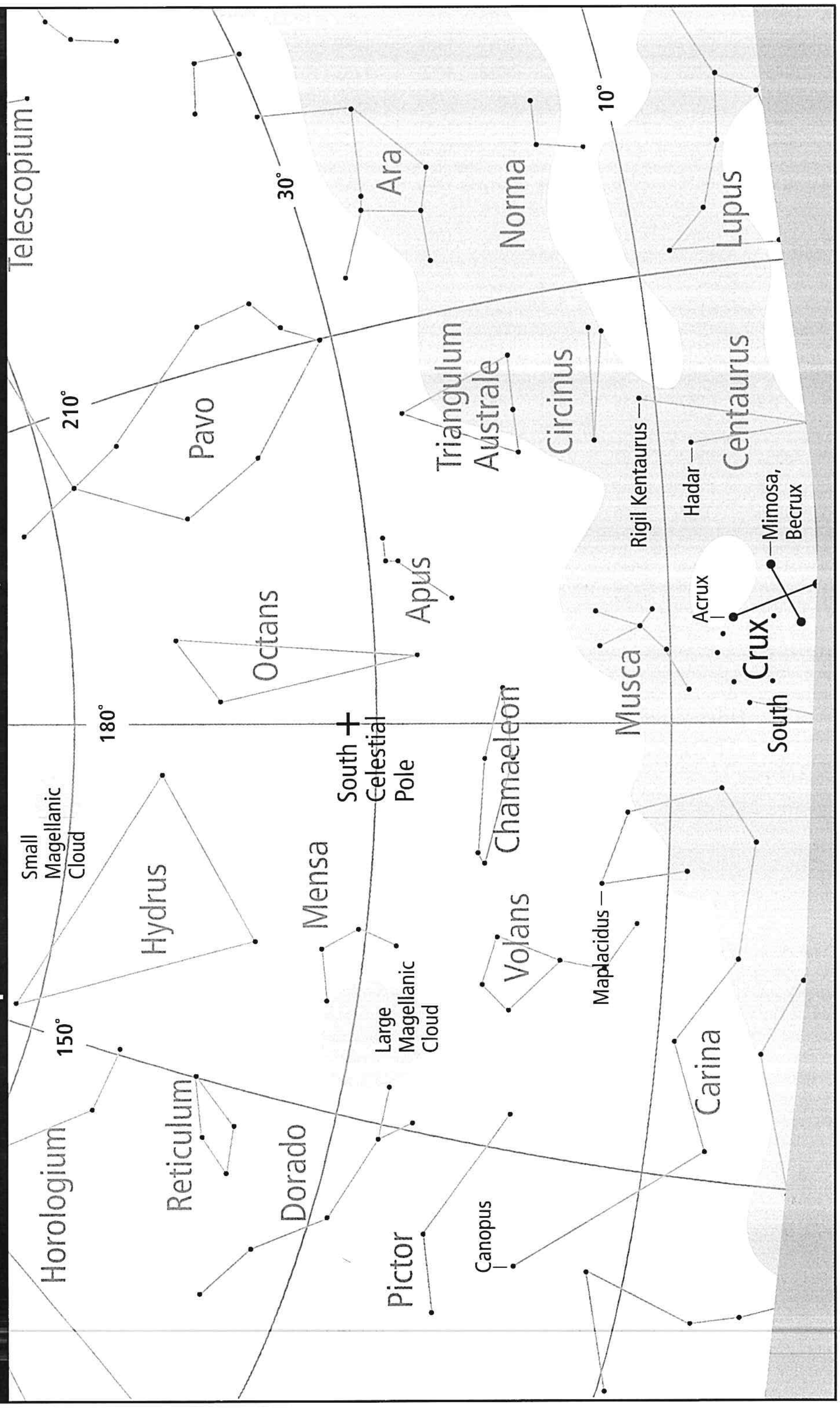
DAY	PHENOMENON h m	Satellite	Event		
14	0446	I	Ec.D.	Eclipse	Disappear
15	0429	I	Tr.E.	Transit	Egress
17	0417	III	Oc.R.	Occult	Reappear
21	0442	II	Tr.E.	Transit	Egress
21	0447		GRS	Great Red Spot	
22	0419	I	Tr.I.	Transit	Ingress
24	0423	III	Ec.D.	Eclipse	Disappear
28	0343	II	Sh.I.	Shadow	Ingress
28	0453	II	Tr.I.	Transit	Ingress

Moons:	I	Io	III	Ganymede
	II	Europa	IV	Callisto
Events:	D	Disappear	R	Reappear
	E	Egress	I	Ingress
	Ec	Eclipse	Oc	Occult
	Sh	Shadow	Tr	Transit
	GRS	Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown		

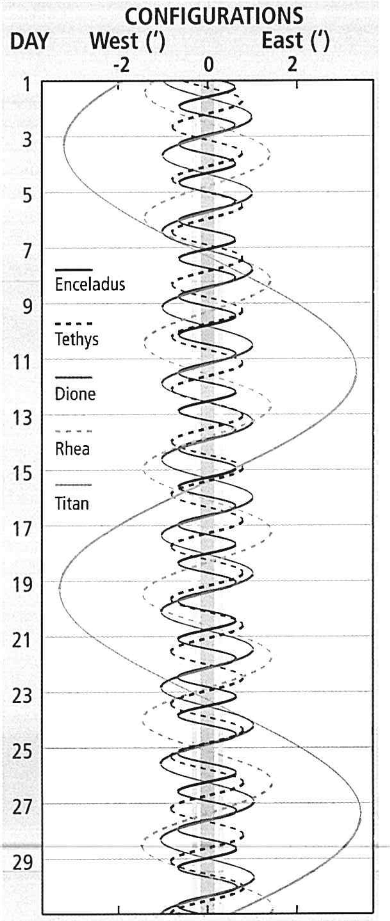
JUPITER MOONS



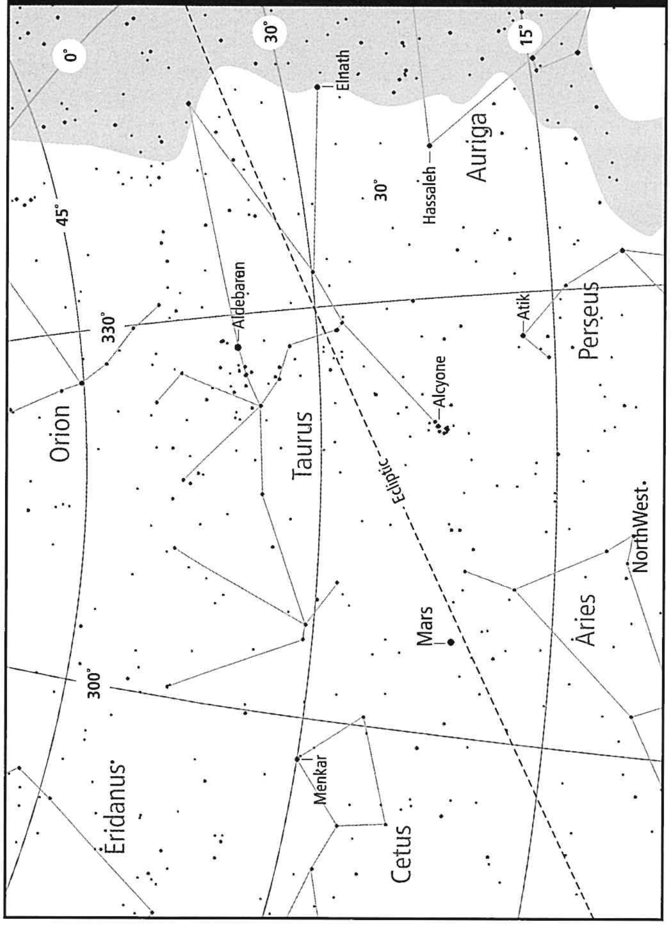
SKYVIEW NOVEMBER 15 8pm – SOUTHERN CROSS



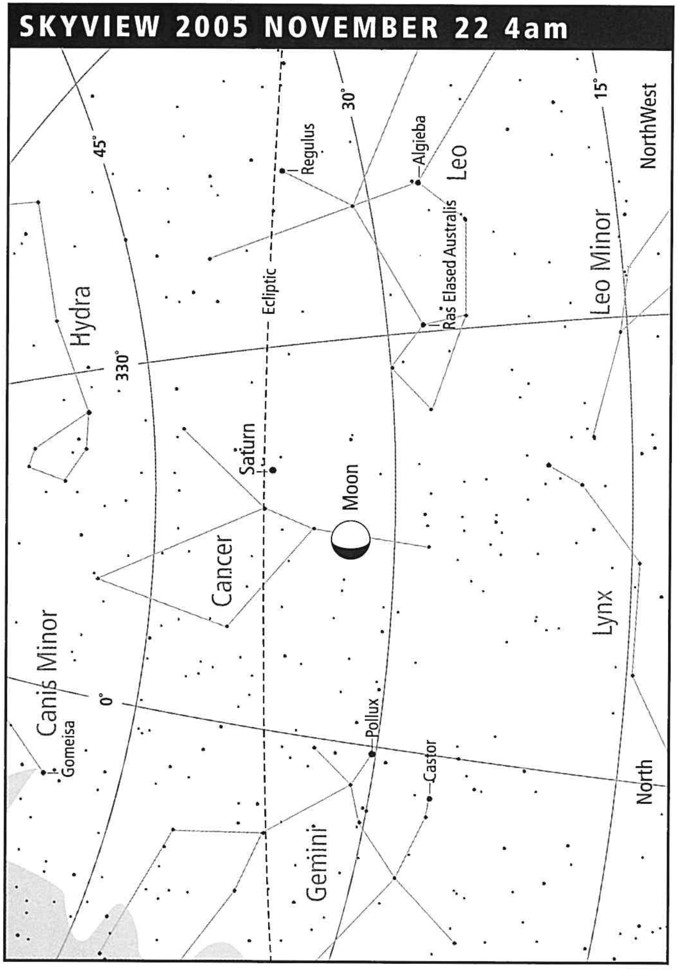
SATURN MOONS



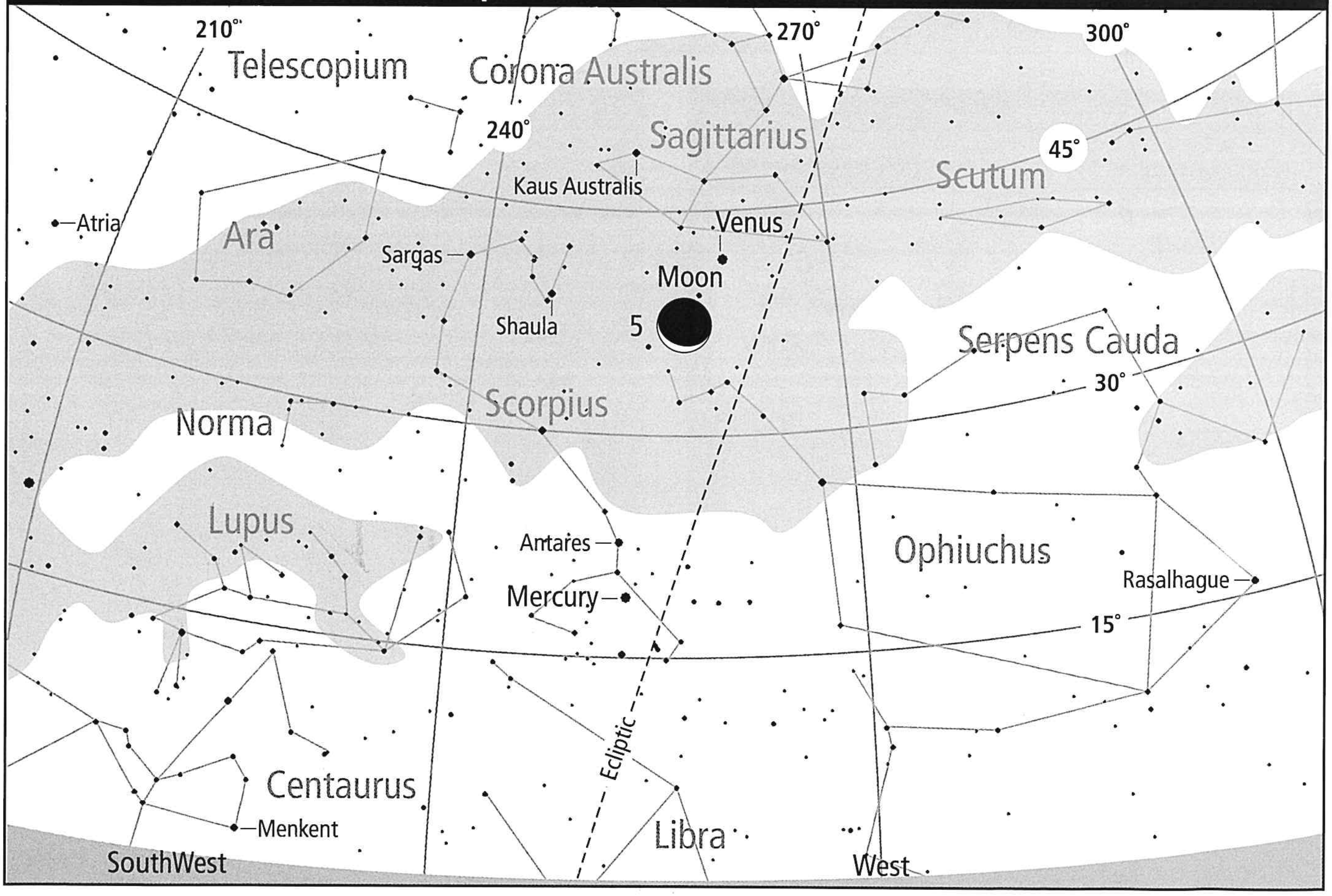
SKYVIEW 2005 NOVEMBER 1 4am



SKYVIEW 2005 NOVEMBER 22 4am



SKYVIEW 2005 NOVEMBER 5 7pm



DECEMBER 2005

HIGHLIGHTS

Mercury *visible in the morning, low in the east before civil twilight.*
Venus *easily visible in the evening sky.*
Mars *visible in the evening and sets after midnight in the constellation Aries.*
Jupiter *visible in the morning in Libra.*
Saturn *rises in the evening in Cancer.*

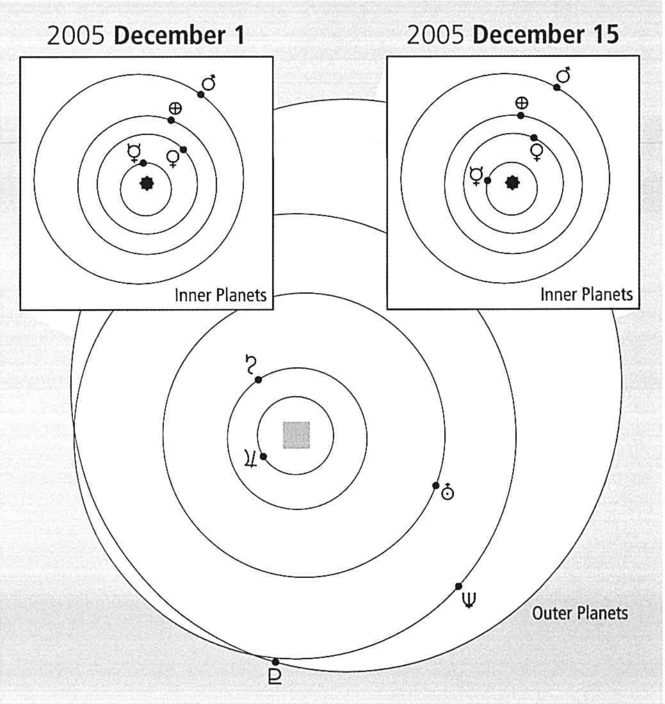
DIARY

Day	Hour	
1		Max activity of chi-Orionid meteor shower
1	23	**New Moon**
4	09	Mercury stationary
5		Max activity of Phoenicid meteor shower
5	02	Venus 2.° N. of Moon
5	13	Moon at perigee
7		Max activity of Pupid-Velid meteor shower
8	18	**First Quarter**
9		Max activity of Monocerotid (Dec.) metr s.
9	21	Venus greatest brilliancy
11		Max activity of sigma-Hydrid meteor shwr
11	07	Mars stationary
12	13	Mars 1.°3 S. of Moon
12	21	Mercury greatest elongation W. (21°)
14		Max activity of Geminid meteor shower
16	00	**Full Moon**
16	12	Pluto in conjunction with Sun
19		Max activity of Coma Berenicid meteor s.
19	17	Saturn 4° S. of Moon
20	15	Mercury 6° N. of Antares
21	11	Moon at apogee
22	03	Solstice
23	13	Venus stationary
24	04	**Last Quarter**
25	22	Spica 0.°9 S. of Moon
27	12	Jupiter 4° N. of Moon
29	10	Antares 0.°2 S. of Moon – Occultation visible from northern Australia
30	08	Mercury 5° N. of Moon
31	11	**New Moon**

SUN+MOON RISE/SET

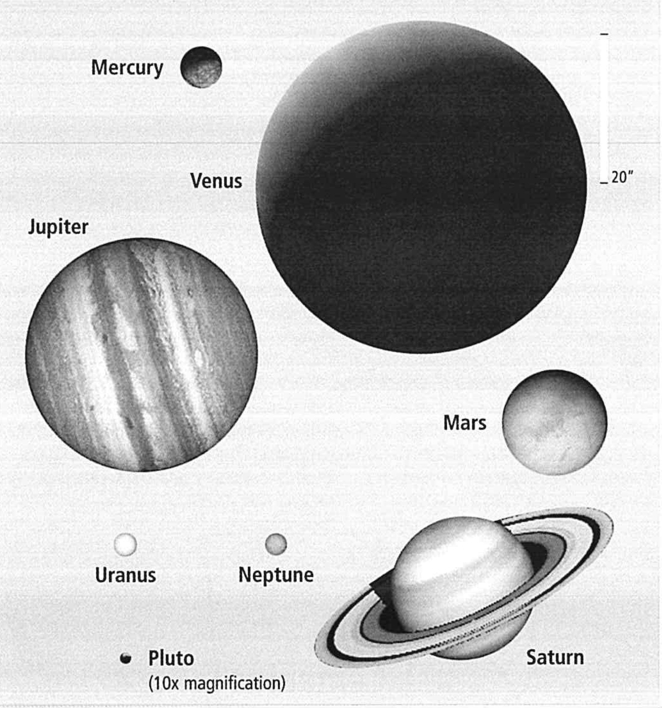
DAY	SUN							MOON		
	Rise h m	Azimuth (°)	Twlght h m	Transit Time h m	Set h m	Azimuth (°)	Twlght h m	Rise h m	Set h m	Illumintn (%)
1	0503	116	0326	1206	1908	243	2046	0418	1903	1
2	0503	117	0326	1206	1909	243	2047	0505	2011	0
3	0503	117	0325	1206	1910	243	2048	0602	2116	3
4	0503	117	0325	1207	1910	243	2049	0707	2213	8
5	0503	117	0325	1207	1911	243	2050	0817	2301	15
6	0503	117	0325	1208	1912	243	2051	0930	2341	24
7	0503	117	0325	1208	1913	242	2052	1040	DNS	34
8	0503	118	0324	1208	1914	242	2053	1148	0016	46
9	0504	118	0324	1209	1914	242	2054	1253	0047	57
10	0504	118	0324	1209	1915	242	2055	1357	0117	68
11	0504	118	0324	1210	1916	242	2055	1501	0146	78
12	0504	118	0325	1210	1917	242	2056	1606	0217	86
13	0504	118	0325	1211	1917	242	2057	1711	0250	92
14	0505	118	0325	1211	1918	242	2058	1815	0329	97
15	0505	118	0325	1212	1919	242	2059	1917	0413	99
16	0505	118	0325	1212	1919	242	2059	2014	0503	100
17	0506	118	0325	1213	1920	242	2100	2104	0558	98
18	0506	118	0326	1213	1920	242	2101	2147	0656	95
19	0506	119	0326	1214	1921	241	2101	2223	0756	90
20	0507	119	0327	1214	1921	241	2102	2254	0854	83
21	0507	119	0327	1215	1922	241	2102	2322	0951	76
22	0508	119	0327	1215	1922	241	2103	2347	1046	67
23	0508	119	0328	1216	1923	241	2103	DNR	1141	58
24	0509	119	0329	1216	1923	241	2104	0012	1235	48
25	0509	119	0329	1217	1924	242	2104	0037	1332	39
26	0510	118	0330	1217	1924	242	2104	0104	1431	29
27	0511	118	0330	1218	1925	242	2105	0134	1534	20
28	0511	118	0331	1218	1925	242	2105	0209	1641	13
29	0512	118	0332	1219	1925	242	2105	0252	1749	6
30	0512	118	0333	1219	1925	242	2105	0344	1857	2
31	0513	118	0333	1220	1926	242	2105	0447	1959	0

PLANET POSITIONS



☿ Mercury ⊕ Earth ♃ Jupiter ⛢ Uranus ♇ Pluto
♀ Venus ♂ Mars ♄ Saturn ♆ Neptune

PLANET APPEARANCE

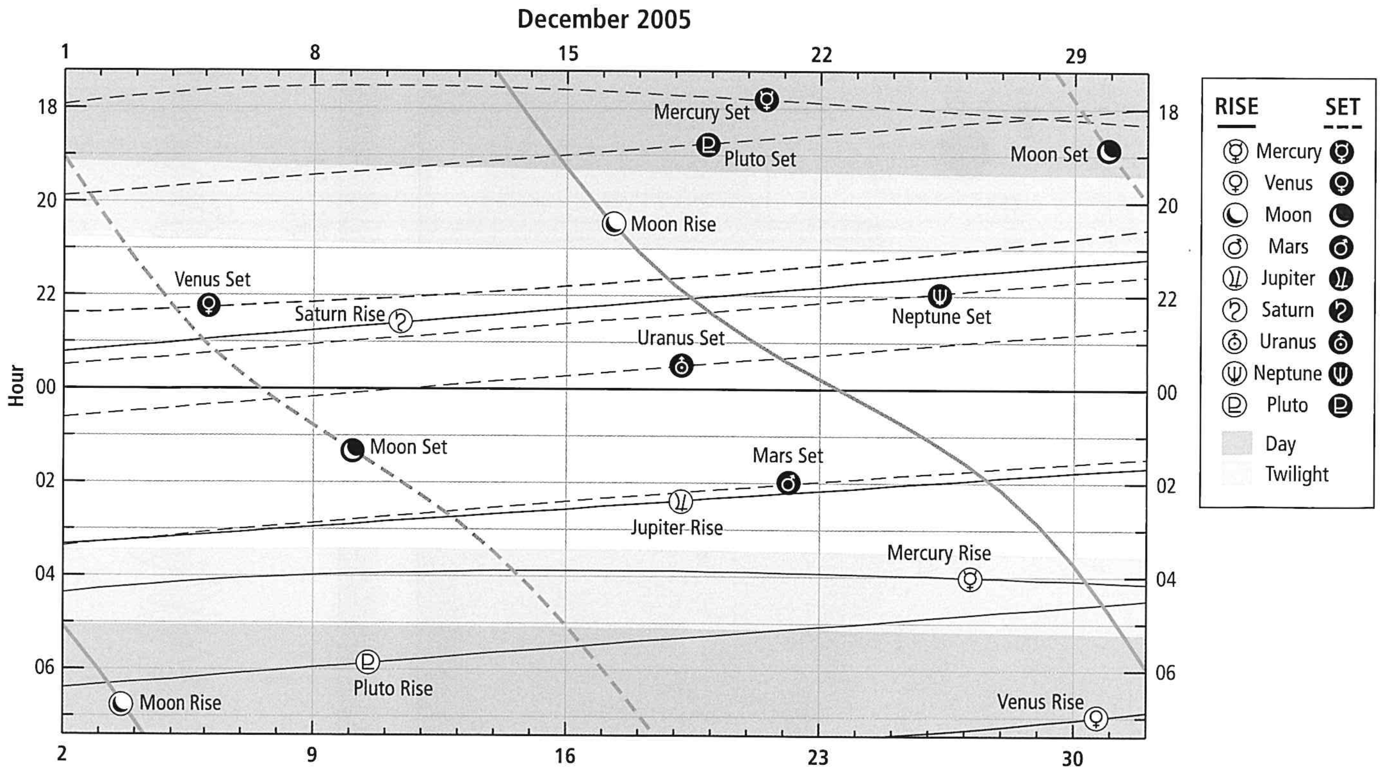


1 degree (1°) = 60 arc minutes (60′) = 3600 arc seconds (3600″)
Therefore 20″ = 1/3′ = 1/180°

PLANETS RISE/SET

DAY	MERCURY		VENUS		MARS		JUPITER		DAY	SATURN		URANUS		NEPTUNE		PLUTO	
	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m		Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m	Rise h m	Set h m
1	0427	1756	0806	2223	1636	0326	0324	1634	1	2313	0948	1145	0041	1002	2330	0628	1953
2	0422	1750	0805	2222	1632	0322	0320	1631	2	2309	0944	1141	0037	0958	2326	0624	1949
3	0417	1745	0805	2220	1627	0317	0317	1628	3	2305	0940	1137	0033	0954	2322	0620	1945
4	0413	1741	0804	2218	1623	0313	0314	1625	4	2301	0936	1133	0029	0950	2319	0616	1941
5	0409	1737	0804	2216	1619	0309	0310	1622	5	2257	0932	1129	0025	0947	2315	0613	1937
6	0406	1735	0803	2214	1614	0304	0307	1619	6	2253	0928	1126	0021	0943	2311	0609	1934
7	0403	1733	0802	2211	1610	0300	0304	1616	7	2249	0924	1122	0018	0939	2307	0605	1930
8	0401	1732	0801	2209	1606	0256	0300	1613	8	2245	0920	1118	0014	0935	2303	0601	1926
9	0359	1731	0800	2206	1602	0252	0257	1610	9	2241	0916	1114	0010	0931	2259	0557	1922
10	0357	1731	0759	2204	1558	0248	0254	1607	10	2237	0912	1110	0006	0927	2255	0554	1919
11	0356	1731	0757	2201	1555	0244	0250	1604	11	2233	0908	1106	0002	0924	2252	0550	1915
11									11				2358				
12	0355	1732	0756	2158	1551	0240	0247	1601	12	2229	0904	1103	2354	0920	2248	0546	1911
13	0354	1733	0754	2155	1547	0236	0244	1558	13	2225	0859	1059	2350	0916	2244	0542	1907
14	0353	1735	0753	2152	1543	0232	0240	1555	14	2221	0855	1055	2347	0912	2240	0538	1904
15	0353	1736	0751	2148	1540	0228	0237	1552	15	2217	0851	1051	2343	0908	2236	0535	1900
16	0353	1738	0749	2145	1536	0224	0234	1549	16	2213	0847	1047	2339	0905	2232	0531	1856
17	0353	1740	0747	2141	1533	0220	0230	1546	17	2209	0843	1043	2335	0901	2229	0527	1852
18	0353	1743	0744	2138	1529	0217	0227	1543	18	2205	0839	1040	2331	0857	2225	0523	1848
19	0353	1745	0742	2134	1526	0213	0224	1540	19	2201	0835	1036	2327	0853	2221	0520	1845
20	0354	1748	0739	2130	1523	0209	0220	1537	20	2157	0830	1032	2323	0849	2217	0516	1841
21	0354	1750	0736	2125	1519	0206	0217	1534	21	2153	0826	1028	2320	0846	2213	0512	1837
22	0355	1753	0733	2121	1516	0202	0213	1530	22	2149	0822	1024	2316	0842	2209	0508	1833
23	0356	1756	0730	2116	1513	0158	0210	1527	23	2144	0818	1021	2312	0838	2205	0504	1830
24	0357	1759	0727	2112	1510	0155	0207	1524	24	2140	0814	1017	2308	0834	2202	0501	1826
25	0358	1802	0723	2107	1507	0151	0203	1521	25	2136	0809	1013	2304	0830	2158	0457	1822
26	0359	1805	0720	2102	1504	0148	0200	1518	26	2132	0805	1009	2300	0827	2154	0453	1818
27	0401	1808	0716	2057	1501	0145	0157	1515	27	2128	0801	1006	2256	0823	2150	0449	1815
28	0402	1811	0712	2051	1458	0141	0153	1512	28	2124	0757	1002	2253	0819	2146	0445	1811
29	0404	1814	0707	2046	1455	0138	0150	1509	29	2120	0753	0958	2249	0815	2142	0442	1807
30	0405	1817	0703	2040	1452	0135	0146	1505	30	2116	0748	0954	2245	0811	2139	0438	1803
31	0407	1820	0658	2034	1449	0131	0143	1502	31	2112	0744	0950	2241	0808	2135	0434	1759

SOLAR SYSTEM RISE/SET



JUPITER MOONS + GREAT RED SPOT

DAY	PHENOMENON h m	Satellite	Event
3	0445		GRS
7	0444	II	Oc.R.
7	0455	I	Ec.D.
8	0355		GRS
8	0415	I	Sh.E.
8	0500	I	Tr.E.
12	0408	III	Sh.E.
14	0315	II	Ec.D.
15	0359	I	Sh.I.
15	0443		GRS
15	0449	I	Tr.I.
16	0416	I	Oc.R.
20	0352		GRS
23	0230	II	Tr.I.
23	0309	I	Ec.D.
23	0313	II	Sh.E.
23	0503	II	Tr.E.
24	0231	I	Sh.E.
24	0328	I	Tr.E.
25	0301		GRS
27	0440		GRS
30	0210		GRS
30	0213	III	Ec.R.
30	0312	II	Sh.I.
30	0420	III	Oc.D.
30	0502	I	Ec.D.
30	0512	II	Tr.I.
31	0214	I	Sh.I.
31	0316	I	Tr.I.
31	0425	I	Sh.E.

Moons:

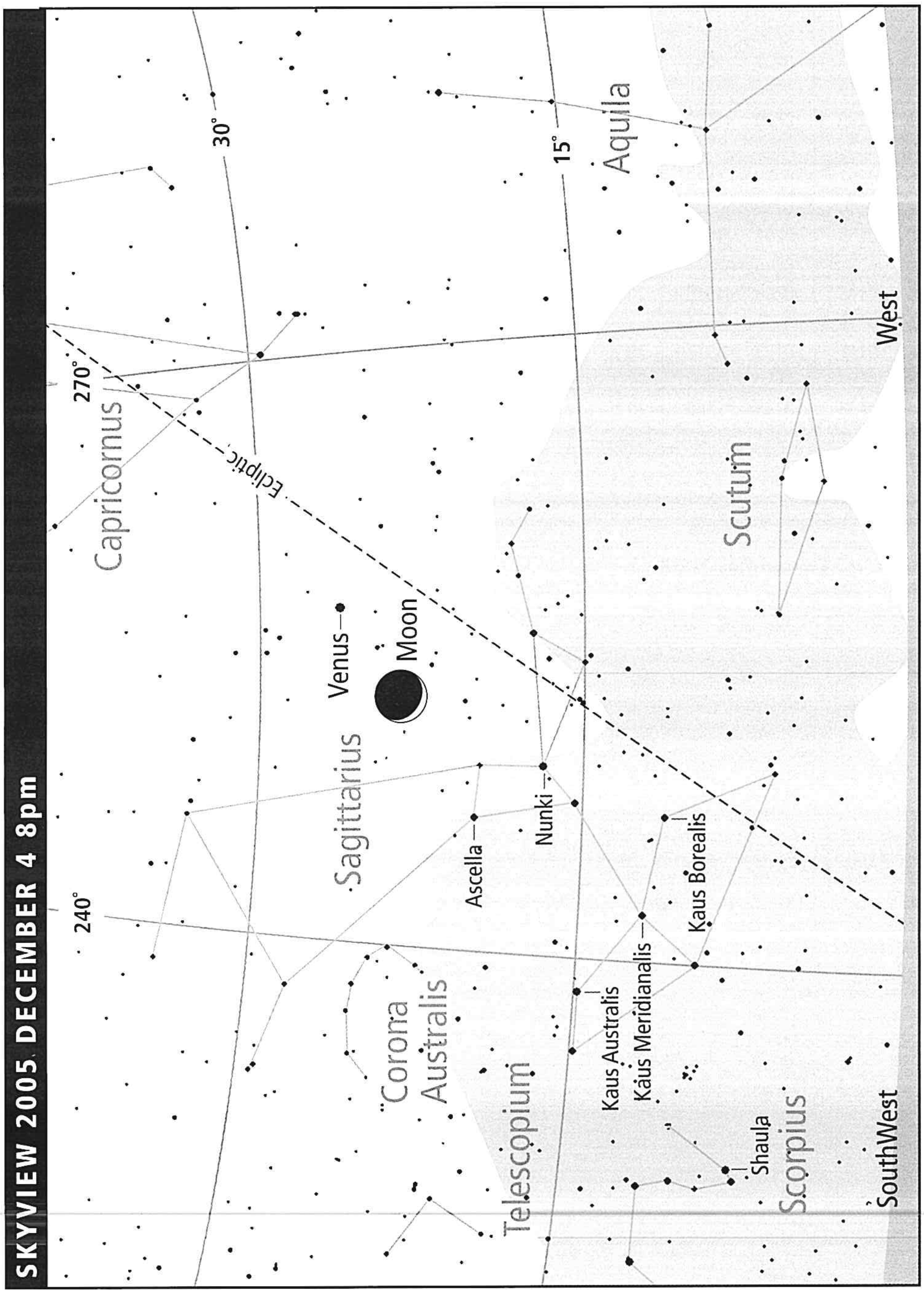
I	Io	III	Ganymede
II	Europa	IV	Callisto

Events:

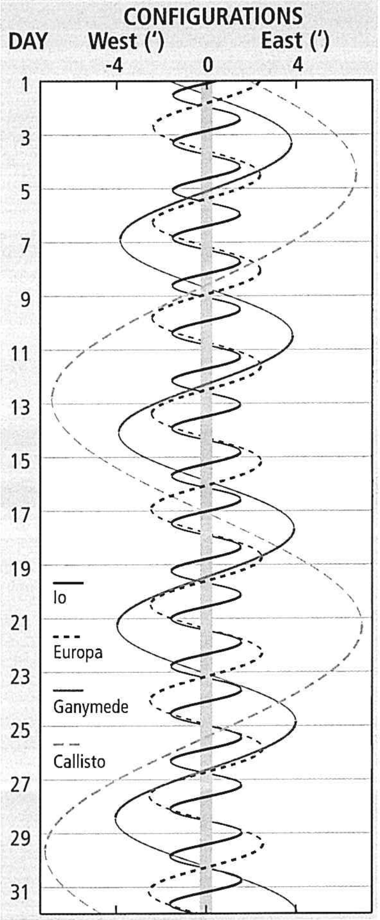
D	Disappear	R	Reappear
E	Egress	I	Ingress
Ec	Eclipse	Oc	Occult
Sh	Shadow	Tr	Transit

GRS Jupiter's Great Red Spot will be visible for approximately 1 hour around time shown

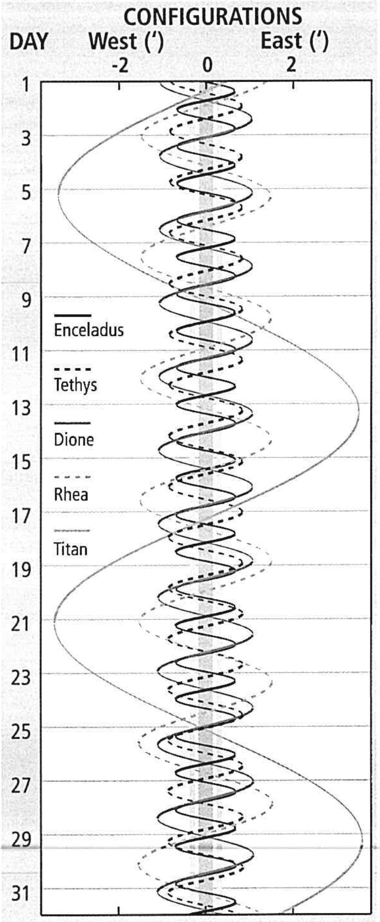
SKYVIEW 2005 DECEMBER 4 8pm



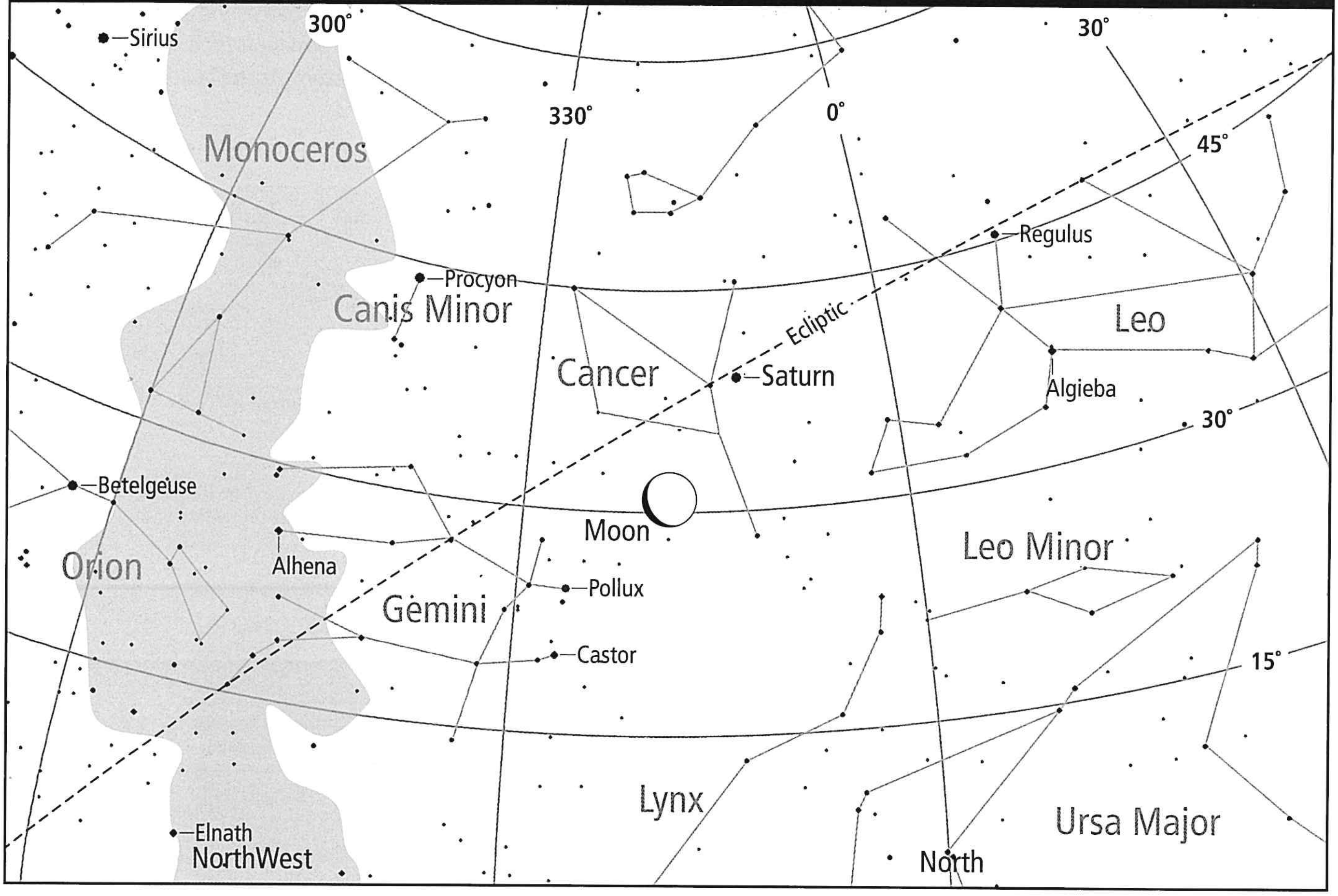
JUPITER MOONS



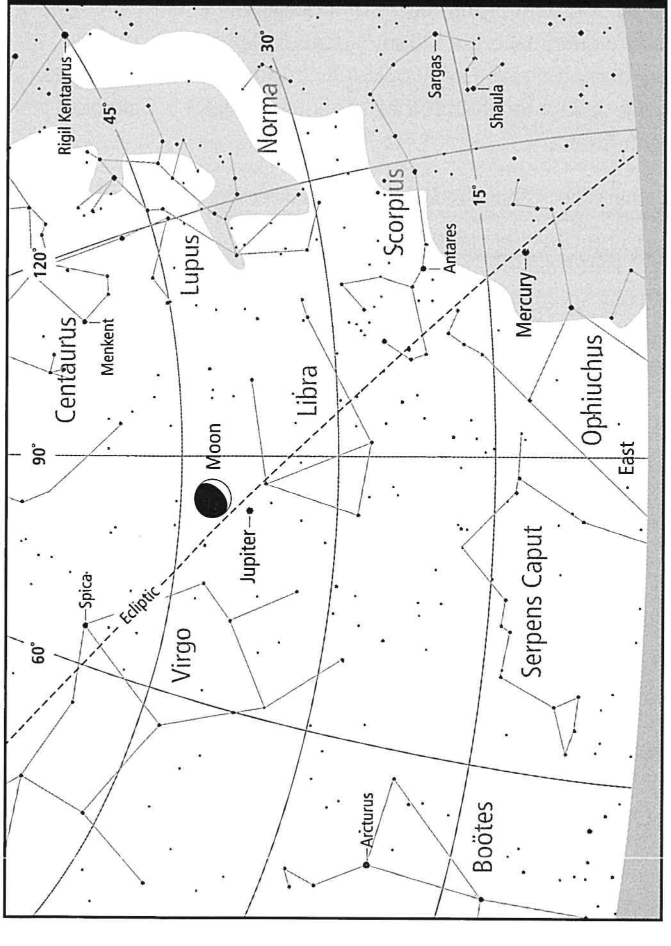
SATURN MOONS



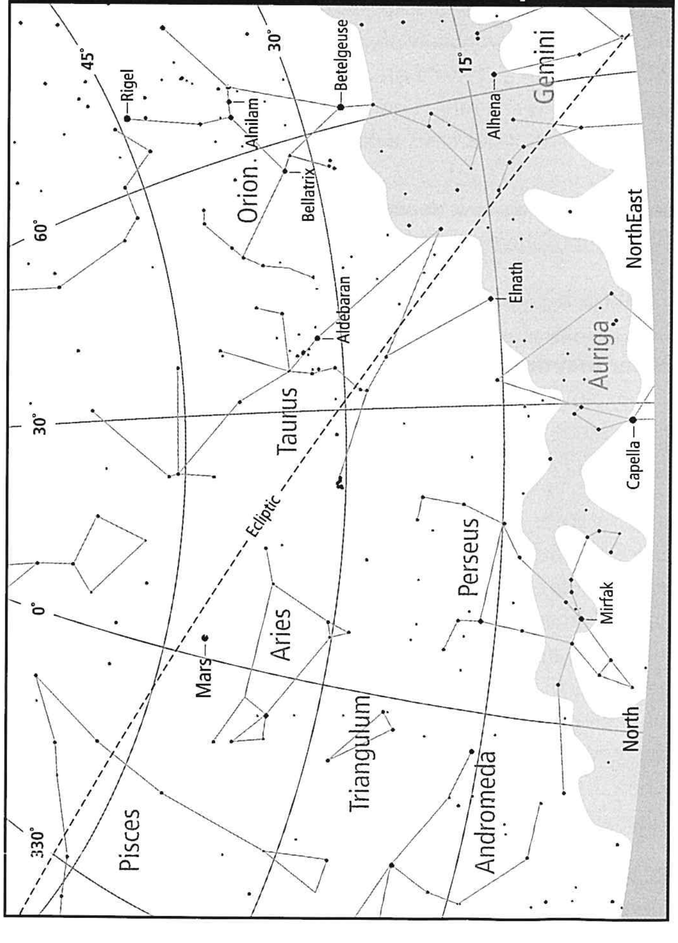
SKYVIEW 2005 DECEMBER 19 4am



SKYVIEW 2005 DECEMBER 27 5am



SKYVIEW 2005 DECEMBER 31 8pm

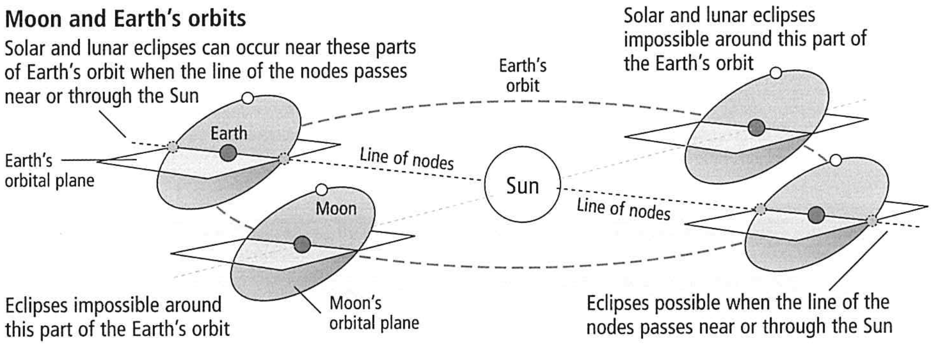


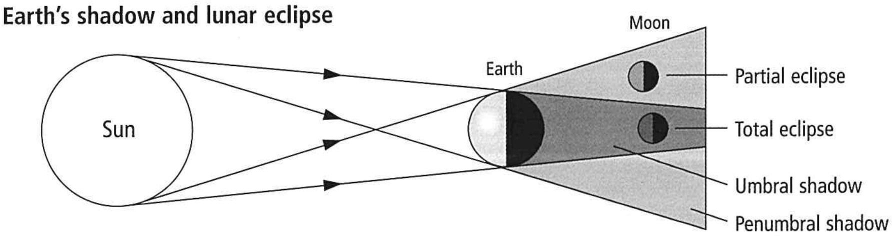
ECLIPSES & OCCULTATIONS

***Some** of the more spectacular and/or rare celestial events are discussed in this section. In particular the date, time and region where the event is actually visible are provided. Consult the definitions in section:* Background & General Information *for a concise description of these events and the terminology used. Some of these events are not visible from Western Australia but are included for completeness and may assist those who travel to other parts of the world.*

Lunar eclipses

Eclipses are a geometrical phenomenon and occur when either the Moon is in the Earth's shadow (a lunar eclipse) or the Earth is shadowed by the Moon (a solar eclipse). This shadowing requires all three objects to be aligned in space. The Earth's full shadow (umbra) is rather large, about three times the width of the Moon at its orbital distance, and lunar eclipses are visible from a wide region of the globe. Total solar eclipses only occur in a region approximately 20km wide (the size of the Moon's full shadow on Earth), that moves across the globe. On average there are about 1.5 umbral lunar eclipses per year, and even more of the fainter penumbral lunar eclipses, where the Moon does not enter the full shadow of the Earth. Also, for any given year there is a $^{2}/_{3}$ chance of having two umbral lunar eclipses.


Moon and Earth's orbits


Earth's shadow and lunar eclipse

Lunar eclipses can only occur at Full Moon phase, where the Moon and Sun are on opposite sides of the Earth. So the Moon starts out very bright and dims significantly in the total eclipse. However, the Moon doesn't necessarily get completely obscured in the shadow – during total eclipse it can have a grey, orange, red or copper hue. Some sunlight can refract and bend through the Earth's atmosphere and this casts a glow on the Moon which is then reflected back to Earth. The colour and brightness can vary between eclipses as it depends on the type and amount of dust in the atmosphere that the sunlight traverses.

Lunar eclipses are necessarily nighttime eclipses, and are safe to view because the Moon is nowhere near as bright as the Sun. **(Solar (daytime) eclipses are unsafe to view.)** Special equipment is not necessary to observe lunar eclipses and a good view can be obtained with the unaided eye. Binoculars are easy to use and assist observation while providing a wide-field view.

Lunar eclipses have played an important part in history. Some historical battles have been lost because of a belief by one side that a lunar eclipse was a bad omen. In 413 BCE, the Syracusan navy destroyed an Athenian fleet after its leader delayed a retreat on account of a total lunar eclipse, in 1453 the defenders of Constantinople were so frightened by a partial lunar eclipse that the fall of the city was hastened, and in 1917 Lawrence of Arabia's force was assisted in the capture of Aqaba when the town's superstitious defenders panicked during a lunar eclipse.

Before the night of a lunar eclipse in 1504, Christopher Columbus tricked disgruntled natives, in what is now Jamaica, to continue supplying him with food when he told them that God would make the Moon "appear inflamed with wrath, denoting the evils God would inflict upon them". The natives were so frightened that they continued supplying Columbus with food.

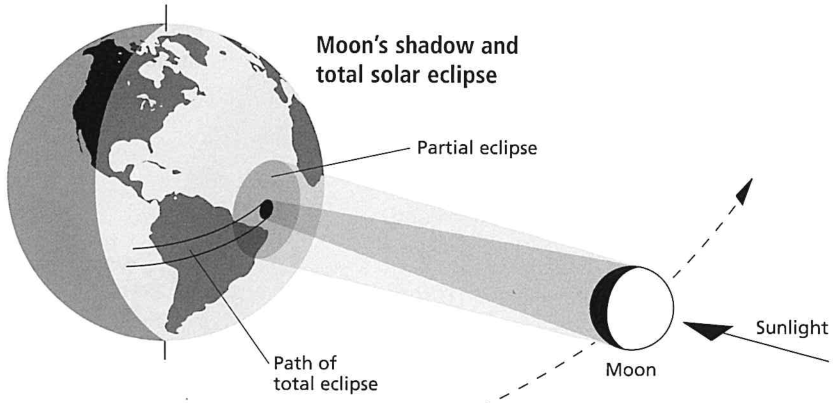
Lunar eclipses have aided our understanding of the world. Greek scientist/philosopher Aristotle (384-322 BCE) used the fact that the Earth's shadow seen in lunar eclipses was always circular to infer that the shape of the Earth was round. Aristarchus of Samos calculated the diameter of the Moon, in the 3rd C BCE, by measuring the duration of a lunar eclipse. Also, a partial solution to the 'longitude problem' was derived in the 17th C CE that involved the simultaneous observation of a lunar eclipse from many locations.

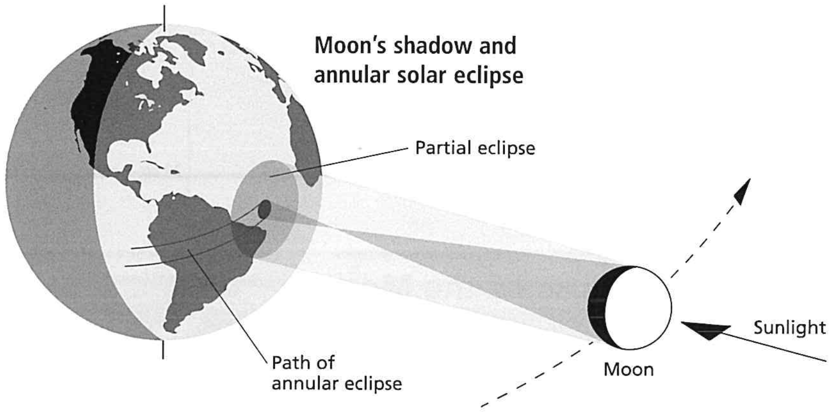
Solar and lunar eclipses often occur in pairs, and this is evident in the two pairs of eclipses that occur this year. This pairing occurs because the orbital plane of Moon about the Earth is aligned with the Earth to Sun direction around these times. This is the basic requirement in order for an eclipse to occur. The orientation of the Moon's orbital plane slowly changes and so eclipses don't always occur at New Moon (when solar eclipses can occur) and Full Moon (when lunar eclipses can occur).

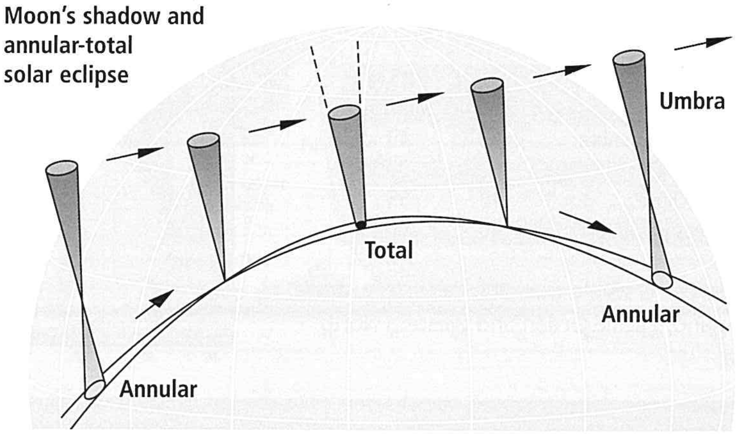
REMEMBER:
never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

Solar eclipses

Solar eclipses are daytime eclipses and can only occur at New Moon phase when the Sun and Earth are on opposite sides of the Moon. The Moon's full shadow (umbra) is significantly smaller than that cast by the Earth and total solar eclipses only occur in a region approximately 20km wide. This shadow moves across the Earth in response to the motion of the Moon in its orbit about Earth, and Earth's orbital motion around the Sun. The penumbra of the Moon is quite large and a wide swath around the region of total eclipse experiences a partial solar eclipse. The amount of partial eclipse uniformly decreases to zero at the outer edge of the penumbra. Sometimes, the Sun, Moon and Earth alignment is not perfect and the eclipse is only partial.







Not only do solar eclipses require a geometrical lineup of the Sun, Moon and Earth, but they also require the angular size of the Moon on the sky to be large enough to obscure the Sun. At most times, the Moon covers approximately the same area on the sky as the Sun. However, at the times when the Moon is furthest from Earth, in its non-circular orbit, it covers a smaller area than that of the Sun. A similar situation occurs when the Sun is larger than average around the time the Earth is closest to the Sun (perihelion). (See the Angular Sizes of the Planets 2005 graph in Section: Solar System Information to see how the apparent size of both the Sun and Moon changes throughout the year.) Solar eclipses at these times cannot be total, and the Sun remains visible, from a region about 20 kilometres wide, as a ring around the edge of the Moon. Such events are called annular solar eclipses. So fine is this size balance that sometimes a solar eclipse can change from annular, to total, and sometimes back to annular. This occurs because of the curvature of the Earth's surface and so the region closest to the Moon can be up to one Earth radius, 6,371 kilometres, closer than surrounding regions. The solar eclipse of 2005 April 8 (April 9 in Australia) is one of the rare annular-total type, but unfortunately it is not visible from anywhere in Australia.

At the present epoch the proportion of each type of solar eclipse is; total 26%, annular 32%, partial 35%, and annular-total 5%. The remainder are relatively rare eclipses that occur at polar regions where only a part of the Moon's umbra, or its extension, intersects the Earth. On average, a given place on the Earth experiences a total eclipse every 375 years and an annular eclipse every 224 years. Total eclipses are more common the further north the latitude because solar eclipses are more common in summer and Earth's perihelion occurs in the northern summer. Annular eclipses are less frequent around equatorial regions because these regions are generally closer to the Moon. Southern regions also experience more annular eclipses than corresponding northern latitudes because the Earth is at aphelion (furthest from the Sun) in the southern summer.

Solar and lunar eclipses often occur in pairs, and this is evident in the two pairs of eclipses that occur this year. This pairing occurs because the orbital plane of Moon about the Earth is aligned with the Earth to Sun direction around these times. This is the basic requirement in order for an eclipse to occur. The orientation of the Moon's orbital plane slowly changes and so eclipses don't always occur at New Moon (when solar eclipses can occur) and Full Moon (when lunar eclipses can occur).

REMEMBER:
never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

April 8: (April 9 in Australia) Annular-Total eclipse of the Sun

This event is not visible from anywhere in Australia.

This event is visible from New Zealand, southern United States, Central America, the Caribbean, and South America except the eastern and southern regions.

The annular eclipse begins at 1854 UT (0254 WAST, April 9) at longitude 175° West and latitude 48° South, becomes a total eclipse at 1905 UT at longitude 154° West and latitude 40° South, reverts to annular at 2203 UT at longitude 89° West and latitude 08° North and ends at 2218 UT (0618 WAST, April 9) at longitude 63° West and latitude 08° North.

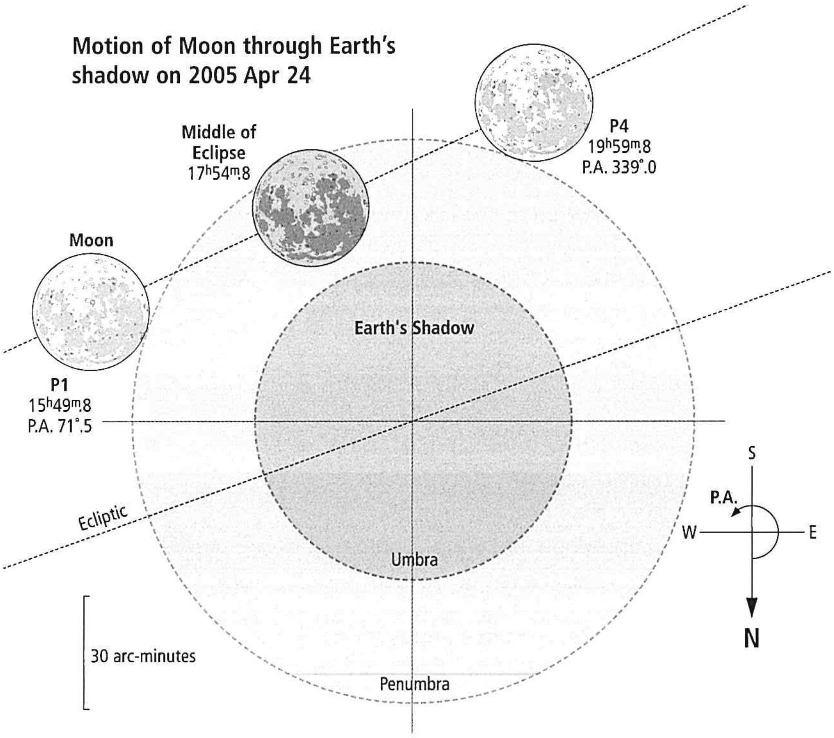
REMEMBER: never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

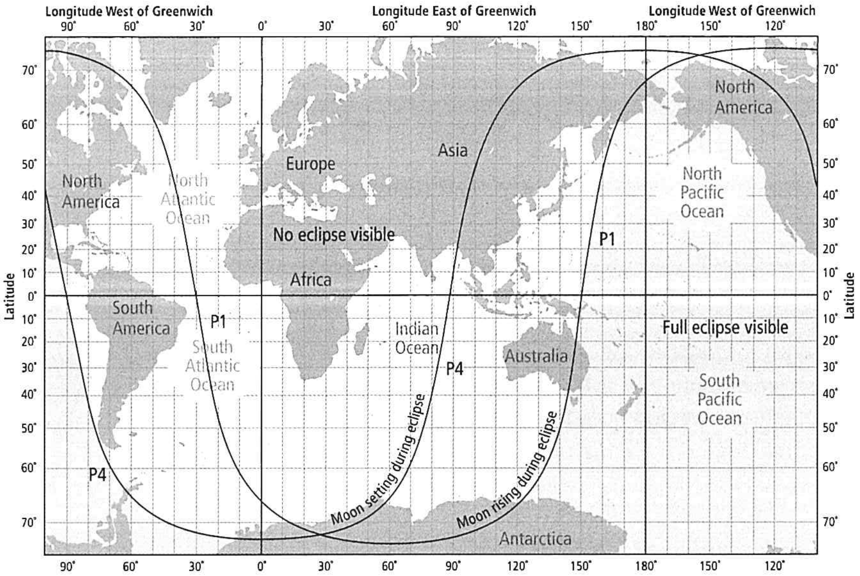
April 24:
Penumbral Eclipse of the Moon

Only the latter portion of this eclipse is visible in WA as the eclipse starts before Moonrise. Furthermore, the Moon does not darken significantly as it only traverses the penumbra, the partial Earth shadow, and does not enter the umbra or full Earth shadow.

	TIME (WAST)	
EVENT	**Hour**	**Minute**
Moon enters penumbra	15	49
Moonrise (Perth)	17	38
Middle of eclipse	17	55
Moon leaves penumbra	20	00

All this eclipse is visible from the Eastern Australia, New Zealand, Pacific Ocean and western North America.


Motion of Moon through Earth's shadow on 2005 Apr 24



Occultations of planets and bright stars by the Moon

An occultation is the obscuration of one celestial body by another of greater apparent diameter; especially the passage of the Moon in front of a star or planet, or the disappearance of a satellite behind the disk of its primary. If the primary source of illumination of a reflecting body is cut off by the occultation, the phenomenon is also called an eclipse. The occultation of the Sun by the Moon is a solar eclipse. The Moon passes in front of the following planets and bright stars during this year.

Moon Occultations 2005

DATE (WAST) d h	Body	Areas of Visibility
Jan 4 10	Jupiter	Central Africa, S. Indian Ocean, **S. Australia**
Jan 8 04	Antares	S.E. Alaska, S.W. Canada
Jan 31 19	Jupiter	S. central Pacific Ocean, part of Antarctica
Feb 4 13	Antares	S. Scandinavia, E. Europe, N. Arabian peninsula, W. Asia
Feb 27 23	Jupiter	S. part of Australia, part of Antarctica
Mar 3 19	Antares	N. America except N.W. part, Central America, Caribbean and N. tip of S. America
Mar 27 00	Jupiter	S. Indian Ocean, S.W. tip of **Australia**, most of Antarctica
Mar 31 01	Antares	N.E. China, S.E. Siberia, Korea, Japan, N. Pacific Ocean, Hawaiian Islands
Apr 23 02	Jupiter	S. half of Africa except S. tip, S. Indian Ocean, part of Antarctica
Apr 27 07	Antares	N.E. Africa, S.E. British Isles, Europe except N. Scandinavia, E. Asia

October 3: Annular Eclipse of the Sun

This event is not visible from anywhere in Australia.

This event is visible from eastern Greenland, Iceland, Europe, Africa except southern tip and western Asia.

The eclipse begins at 0843 UT (1643 WAST) at longitude 39° West and latitude 48° North and ends at 1220 UT (2020 WAST) at longitude 83° East and latitude 10° South.

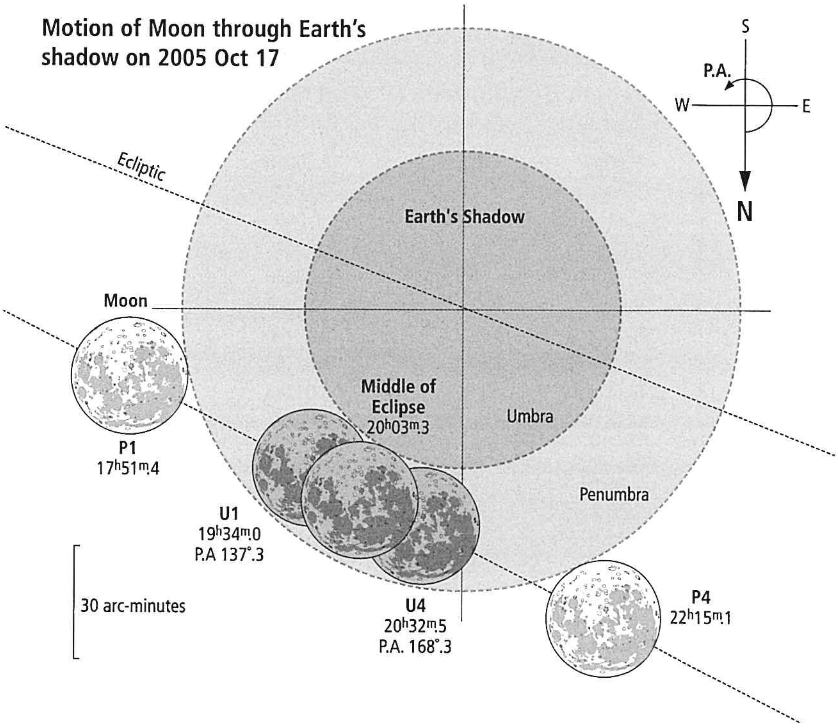
REMEMBER: never look at the Sun with the unaided eye or with an optical instrument. You may suffer permanent eye damage.

October 17: Partial Eclipse of the Moon

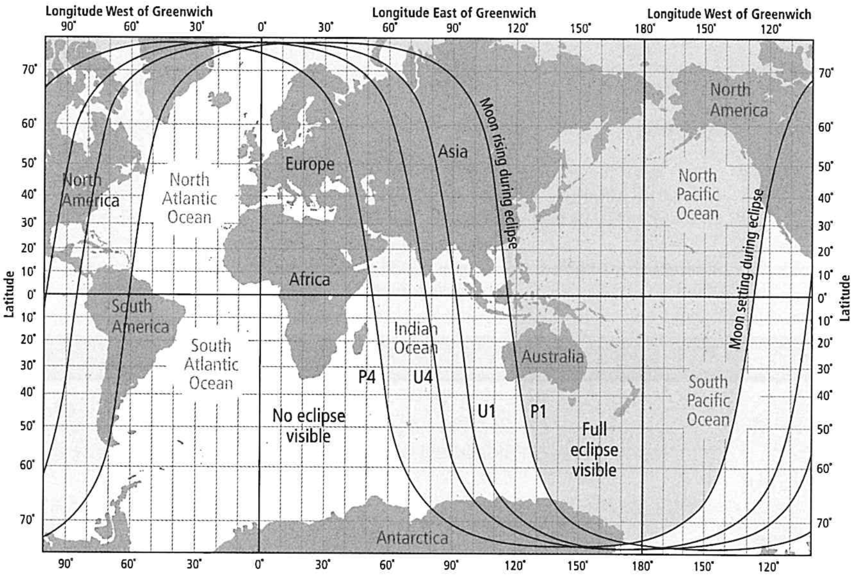
This eclipse starts before Moonrise in WA. Furthermore, the Moon does not darken significantly as it mainly traverses the penumbra, the partial Earth shadow and only just touches the umbra, or full Earth shadow. It will be marginally darker than the April 24 penumbral eclipse of the Moon.

	TIME (WAST)	
EVENT	Hour	Minute
Moon enters penumbra	17	51
Moonrise (Perth)	18	22
Moon enters umbra	19	34
Moon leaves umbra	20	32
Moon leaves penumbra	22	15

This event is visible in its entirety from parts of eastern Australia, eastern Asia and western North America.



Motion of Moon through Earth's shadow on 2005 Oct 17



Moon Occultations 2005

DATE (WAST) d h	Body	Areas of Visibility
May 20 06	Jupiter	Caribbean, S. part of Central America, northern S. America, S. part of S. Africa
May 24 16	Antares	N.E. Pacific Ocean, N. America except N. part, Central America, Caribbean, N. tip of S. America
May 31 17	Mars	Part of Antarctica, S. part of S. America, central W. Africa
June 16 15	Jupiter	Indonesia, Philippines, **N. Australia**, Fiji, W. Samoa, New Zealand except S. tip
June 21 02	Antares	S.E. Europe, most of Arabia, southern and central Asia, N. Philippines
July 14 02	Jupiter	S. America except N. part, part of Antarctica
July 18 12	Antares	N.E. Pacific Ocean, S. and W. parts of the United States, Caribbean, N. part of S. America
Aug 8 12	Venus	Alaska, N.W. Canada
Aug 10 16	Jupiter	S. Indian Ocean, part of Antarctica
Aug 14 21	Antares	Arabian peninsula, S.W. Asia, India, S.E. Asia, Indonesia, Philippines, N. tip of Australia
Sept 7 14	Spica	N.E. Siberia, Kamchatka
Sept 7 17	Venus	S. part of Africa, part of Antarctica
Sept 11 04	Antares	S.W. tip of the United States, Central America, Caribbean, N. half of S. America, W. central Africa
Oct 8 09	Antares	Central Pacific Ocean, W. Samoa, W. tip of northern S. America
Nov 1 03	Spica	N.E. part of N. America except eastern tip
Nov 4 15	Antares	Arabia, E. tip of Africa, India, Indonesia, Philippines, **N. Australia**
Nov 28 12	Spica	N. China, central and N. Russia
Dec 12 13	Mars	N.E. Siberia
Dec 25 22	Spica	Northern and Central America except S.W. part, Caribbean and N. tip of S. America
Dec 29 10	Antares	India, S.E. Asia, Indonesia, Philippines, **N. Australia**, Fiji, W. Samoa

SOLAR SYSTEM INFORMATION

SUN & PLANET DATA

NAME	MEAN RADIUS (kilometres)	VOLUME (Earth =1)	FLATTENING (Earth =1)	MASS (x 10^{23} kg)	DENSITY (g/cm^3)	EQUATORIAL GRAVITY (m/s^2)	GEOMETRIC ALBEDO
Sun	696000	1305000	0.00005	19890850	1.407	274.0	-
Mercury	2440 ± 1	0.056	0.0000	3.302	5.427	3.701	0.106
Venus	6051.84 ± 0.01	0.857	0.000	48.685	5.204	8.87	0.65
Earth	6371.01 ± 0.02	1	0.00335	59.736	5.515	9.780327	0.367
Mars	3389.92 ± 0.04	0.151	0.00648	6.4185	3.9335 ± 0.0004	3.69	0.15
Jupiter	69911 ± 6	1321	0.06487	18986	1.326	23.12 ± 0.01	0.52
Saturn	58232 ± 6	764	0.09796	5684.6	0.6873	8.96 ± 0.01	0.47
Uranus	25362 ± 12	63	0.02293	868.32	1.318	8.69 ± 0.01	0.51
Neptune	24624 ± 21	58	0.01708	1024.3	1.638	11.00 ±0.05	0.41
Pluto	1151	0.006	0.0000	0.1314 ± 0.0018	2	0.655	0.3

NAME	V (1,0) Brightness at opposition	SIDEREAL ROTATION PERIOD (hours)	SIDEREAL ORBIT PERIOD (Years)	a Semi-major axis (AU)	e eccentricity	i inclination (°)	OBLIQUITY (°)
Sun	-26.74	609.12	-	-	-	-	7.25
Mercury	-0.42	1407.509	0.2408467	0.38709893	0.20563069	7.00487	0.01
Venus	-4.4	-5832.444	0.61519726	0.72333199	0.00677323	3.39471	177.36
Earth	-3.86	23.93419	1.0000174	1.00000011	0.01671022	0.00005	23.45
Mars	-1.52	24.622962	1.8808476	1.52366231	0.09341233	1.85061	25.19
Jupiter	-9.4	9.92425	11.862615	5.20336301	0.04839266	1.30530	3.13
Saturn	-8.88	10.65622	29.447498	9.53707032	0.05415060	2.48446	26.73
Uranus	-7.19	17.24 ± 0.01	84.016846	19.19126393	0.04716771	0.76986	97.77
Neptune	-6.87	16.11 ± 0.01	164.79132	30.06896348	0.00858587	1.76917	28.32
Pluto	-1.0	153.28	247.92065	39.48168677	0.24880766	17.14175	122.53

Legend:

Flattening	Degree to which poles are flattened with respect to the equator (difference between polar and equatorial radius as a proportion of the mean radius)
Geometric Albedo	Proportion of incident light reflected
Sidereal Rotation Period	Rotation period as measured from a fixed star (not measured from the orbiting Earth)
Sidereal Orbit Period	Orbital period as measured from a fixed star (not measured from the orbiting Earth)
V (1,0)	Brightness at opposition (magnitude)
a	Semi-major Axis
e	Eccentricity
i	Inclination
Obliquity	Angle between rotation axis and orbital axis
±	The uncertainty in the quantity

Data from NASA/JPL (http://ssd.jpl.nasa.gov/)

MOON & SATELLITE DATA

NAME	1/m_{pl} Proportion of Planet Mass	MEAN RADIUS (kilometres)	MEAN DENSITY (g/cm^3)	MAGNITUDE (V_0 or R)	GEOMETRIC ALBEDO	a Semi-major axis (km)	e eccentricity	i inclination (°)	P Sidereal Period (days)
EARTH									
Moon	0.0123	1737.5 ± 0.1	3.344 ± 0.005	-12.74	0.12	384400	0.0554	5.16	27.322
MARS									
Deimos	3.740E-09	6.2 ± 0.18	2.247 ± 0.251	12.45 ± 0.05	0.068 ± 0.007	23460	0.0002	1.793	1.262
Phobos	1.651E-08	11.1 ± 0.15	1.867 ± 0.076	11.4 ± 0.2	0.071 ± 0.012	9380	0.0151	1.075	0.319
JUPITER									
Adrastea	3.95E-12	8.2 ± 2.0	3.0	18.7	0.100 ± 0.045	129000	0.0018	0.054	0.298
Aitne	2.37E-14	1.5	2.6	22.7	0.04	23229000	0.2643	165.091	730.18
Amalthea	1.09E-09	83.5 ± 2.4	0.849 ± 0. 199	14.1 ± 0.2	0.090 ± 0.005	181400	0.0031	0.388	0.498
Ananke	1.58E-11	14	2.6	18.75 ± 0.02	0.04	21276000	0.2435	148.889	629.77
Autonoe	4.74E-14	2.0	2.6	22.0	0.04	24046000	0.3168	152.416	760.95
Callirrhoe	4.58E-13	4.3	2.6	20.73 ± 0.04	0.04	24103000	0.2828	147.158	758.77
Callisto	5.67E-05	2410.3 ± 1.5	1.834 ± 0.004	5.65 ± 0.10	0.17 ± 0.02	1882700	0.0074	0.187	16.69
Carme	6.95E-11	23	2.6	17.55 ± 0.02	0.04	23404000	0.2533	164.907	734.17
Chaldene	3.95E-14	1.9	2.6	22.5	0.04	23100000	0.2519	165.191	723.70
Elara	4.58E-10	43	2.6	16.32 ± 0.02	0.04	11741000	0.2174	26.627	259.64
Erinome	2.37E-14	1.6	2.6	22.8	0.04	23196000	0.2665	164.934	728.51
Euanthe	2.37E-14	1.5	2.6	22.8	0.04	20797000	0.2321	148.910	620.49
Euporie	7.89E-15	1.0	2.6	23.1	0.04	19304000	0.1432	145.767	550.74
Europa	2.53E-05	1560.8 ± 0.5	3.013 ± 0.005	5.29 ± 0.02	0.67 ± 0.03	671100	0.0094	0.469	3.551
Eurydome	2.37E-14	1.5	2.6	22.7	0.04	22865000	0.2759	150.274	717.33
Ganymede	7.81E-05	2631.2 ± 1.7	1.942 ± 0.005	4.61 ± 0.03	0.43 ± 0.02	1070400	0.0011	0.170	7.155
Harpalyke	6.31E-14	2.2	2.6	22.2	0.04	20858000	0.2268	148.644	623.31
Hermippe	4.74E-14	2.0	2.6	22.1	0.04	21131000	0.2096	150.725	633.90
Himalia	3.55E-09	85	2.6	14.62 ± 0.02	0.04	11461000	0.1623	27.496	250.56
Io	4.70E-05	1821.6 ± 0.5	3.528 ± 0.006	5.02 ± 0.03	0.63 ± 0.02	421800	0.0041	0.036	1.769
Iocaste	1.03E-13	2.6	2.6	21.8	0.04	21061000	0.2160	149.429	631.60

MOON & SATELLITE DATA (continued)

NAME	$1/m_{pl}$ Proportion of Planet Mass	MEAN RADIUS (kilometres)	MEAN DENSITY (g/cm^3)	MAGNITUDE (V_0 or R)	GEOMETRIC ALBEDO	a Semi-major axis (km)	e eccentricity	i inclination (°)	P Sidereal Period (days)
Isonoe	3.95E-14	1.9	2.6	22.5	0.04	23155000	0.2471	165.268	726.25
Kale	7.89E-15	1.0	2.6	23.0	0.04	23217000	0.2599	164.996	729.47
Kalyke	1.03E-13	2.6	2.6	21.8	0.04	23566000	0.2465	165.159	742.03
Leda	5.76E-12	10	2.6	19.50 ± 0.03	0.04	11165000	0.1636	27.457	240.92
Lysithea	3.32E-11	18	2.6	18.25 ± 0.04	0.04	11717000	0.1124	28.302	259.20
Magaclite	3.63E-13	2.7	2.6	21.7	0.04	23493000	0.4197	152.769	752.88
Metis	3.95E-12	21.5 ± 2.0	3.0	17.5	0.061 ± 0.003	128000	0.0012	0.019	0.295
Orthosie	7.89E-15	1.0	2.6	23.1	0.04	20720000	0.2808	145.921	622.56
Pasiphae	1.58E-10	30	2.6	17.00 ± 0.20	0.04	23624000	0.4090	151.431	743.63
Pasithee	7.89E-15	1.0	2.6	23.2	0.04	23004000	0.2675	165.138	719.44
Praxidike	2.29E-13	3.4	2.6	21.2	0.04	20907000	0.2308	148.967	625.38
Sinope	3.95E-11	19	2.6	18.05 ± 0.02	0.04	23939000	0.2495	158.109	758.90
Sponde	7.89E-15	1.0	2.6	23.0	0.04	23487000	0.3121	150.998	748.34
Taygete	8.68E-14	2.5	2.6	21.9	0.04	23280000	0.2525	165.272	732.41
Thebe	5.76E-12	49.3 ± 2.0	3.0	16.0	0.047 ± 0.003	221900	0.0177	1.070	0.675
Themisto	3.63E-13	4.0	2.6	21.0	0.04	7284000	0.2426	43.259	130.02
Thyone	4.74E-14	2.0	2.6	22.3	0.04	20939000	0.2286	148.509	627.21
S/2000 J 11	4.74E-14	2.0	2.6	22.4	0.04	12555000	0.2484	28.273	286.95
S/2002 J 1	2.37E-14	1.5	2.6	22.8	0.04	22931000	0.2588	165.001	723.90
S/2003 J 1	4.74E-14	2	2.6	22.6	0.04	23661000	0.2721	165.482	746.39
S/2003 J 2	7.89E-15	1	2.6	23.2	0.04	29541000	0.2255	160.638	979.99
S/2003 J 3	7.89E-15	1	2.6	23.4	0.04	20221000	0.1970	147.550	583.88
S/2003 J 4	7.89E-15	1	2.6	23	0.04	23930000	0.3618	149.581	755.24
S/2003 J 5	4.74E-14	2	2.6	22.4	0.04	23495000	0.2478	165.247	738.73
S/2003 J 6	4.74E-14	2	2.6	22.6	0.04	21263000	0.1558	154.773	634.77
S/2003 J 7	4.74E-14	2	2.6	22.5	0.04	23981000	0.4322	158.257	761.50
S/2003 J 8	2.37E-14	1.5	2.6	22.9	0.04	23947000	0.3276	155.214	739.60
S/2003 J 9	7.89E-16	0.5	2.6	23.7	0.04	23384000	0.2632	165.079	733.29
S/2003 J 10	7.89E-15	1	2.6	23.6	0.04	23042000	0.4295	165.080	716.25
S/2003 J 11	7.89E-15	1	2.6	23.7	0.04	24043000	0.2640	165.504	764.74
S/2003 J 12	7.89E-16	0.5	2.6	23.9	0.04	15912000	0.6056	151.909	489.52
S/2003 J 13	7.89E-15	1	2.6	23.2	0.04	24349000	0.3189	149.255	751.91
S/2003 J 14	7.89E-15	1	2.6	23.6	0.04	23614000	0.3439	144.507	779.23
S/2003 J 15	7.89E-15	1	2.6	23.5	0.04	22627000	0.1916	146.510	689.77
S/2003 J 16	7.89E-15	1	2.6	23.3	0.04	20963000	0.2245	148.534	616.36
S/2003 J 17	7.89E-15	1	2.6	23.4	0.04	23001000	0.2379	164.917	714.47
S/2003 J 18	7.89E-15	1	2.6	23.4	0.04	20514000	0.0148	146.062	596.59
S/2003 J 19	7.89E-15	1	2.6	23.7	0.04	23533000	0.2557	165.161	740.42
S/2003 J 20	2.37E-14	1.5	2.6	23.0	0.04	16989000	0.4297	51.395	456.10
S/2003 J 21	7.89E-15	1	2.6	23.3	0.04	21069000	0.2273	148.635	620.04
S/2003 J 22	-	-	-	-	-	21162000	0.2206	151.417	628.09
S/2003 J 23	-	-	-	-	-	23563000	0.2714	146.314	732.44
SATURN									
Albiorix	3.69E-11	13	2.3	20.5	0.06	16394000	0.4791	33.979	783.47
Atlas	1.90E-11	16 ± 4	0.63	19.0	0.4	137700	0.000	0.000	0.602
Calypso	6.33E-12	9.5 ± 1.5	1.0	18.7	0.7	294700	0.0005	1.473	1.888
Dione	1.93E-06	559. ± 5.	1.490 ± 0.040	10.4	0.6	377400	0.0002	0.002	2.737
Enceladus	1.83E-07	249.4 ± 0.2	1.603 ± 0.345	11.8	1.0	238100	0.0001	0.010	1.370
Epimetheus	9.41E-10	59.5 ± 3.0	0.606 ± 0.096	15.6	0.5	151400	0.0205	0.335	0.694
Erriapo	1.34E-12	4.3	2.3	23.0	0.06	17604000	0.4740	34.469	871.25
Helene	4.48E-11	16 ± 4	1.5	18.4	0.6	377400	0.0001	0.212	2.737
Hyperion	1.90E-08	133 ± 8	1.1 ± 0.6	14.4	0.3	1464100	0.0175	0.568	21.28
Iapetus	3.42E-06	718 ± 8	1.253 ± 0.168	11	0.6	3560800	0.0284	7.570	79.33
Ijiraq	2.11E-12	5	2.3	22.6	0.06	11442000	0.3215	46.730	451.47
Janus	3.39E-09	88.8 ± 4.0	0.656 ± 0.094	14.4	0.6	151500	0.0073	0.165	0.695
Kiviuq	5.80E-12	7	2.3	22.0	0.06	11365000	0.3336	46.148	449.22
Mimas	6.72E-08	198.6 ± 0.6	1.169 ± 0.023	12.8	0.6	185600	0.0206	1.566	0.942
Mundilfari	3.69E-13	2.8	2.3	23.8	0.06	18722000	0.2078	167.476	951.56
Paaliaq	1.45E-11	9.5	2.3	21.3	0.06	15198000	0.3632	45.077	686.94
Pan	4.75E-12	10 ± 3	0.63	19.4	0.5	133600	0.0000	0.000	0.575
Pandora	3.43E-10	42 ± 2	0.63 ±0.1	16.4	0.5	141700	0.0044	0.000	0.629
Phoebe	1.27E-08	110 ± 10	1.3 ±0.7	16.4	0.081 ± 0.002	12944300	0.1644	174.751	548.21
Prometheus	5.80E-10	50 ± 3	0.63 ±0.1	15.8	0.6	139400	0.0023	0.000	0.613
Rhea	4.08E-06	764 ± 4	1.240 ± 0.044	9.6	0.6	527100	0.0009	0.327	4.518
Siarnaq	6.85E-11	16	2.3	20.1	0.06	18195000	0.2962	45.539	895.55

MOON & SATELLITE DATA (continued)

NAME	$1/m_{pl}$ Proportion of Planet Mass	MEAN RADIUS (kilometres)	MEAN DENSITY (g/cm^3)	MAGNITUDE (V_0 or R)	GEOMETRIC ALBEDO	a Semi-major axis (km)	e eccentricity	i inclination (°)	P Sidereal Period (days)
Skathi	5.54E-13	3.2	2.3	23.6	0.06	15641000	0.2690	152.621	728.18
Suttungr	3.69E-13	2.8	2.3	23.9	0.06	19465000	0.1140	175.811	1016.51
Tarvos	4.75E-12	6.5	2.3	22.1	0.06	18239000	0.5365	33.495	926.13
Telesto	1.27E-11	12 ± 3	1.0	18.5	1.0	294700	0.0010	1.158	1.888
Tethys	1.09E-06	529.8 ± 1.5	0.991 ± 0.009	10.2	0.8	294700	0.0001	0.168	1.888
Thrymr	3.69E-13	2.8	2.3	23.9	0.06	20219000	0.4852	175.815	1091.76
Titan	2.37E-04	2575 ± 2	1.881 ± 0.005	8.4	0.2	1221900	0.0288	1.634	15.95
Ymir	8.70E-12	8	2.3	21.7	0.06	23130000	0.3339	173.104	1315.33
S/2003 S 1	6.06E-13	3.3	2.3	24.0	0.06	18719000	0.3522	134.592	956.19
S/2004 S 1	-	-	-	-	-	-	-	-	-
S/2004 S 2	-	-	-	-	-	-	-	-	-
URANUS									
Ariel	1.56E-05	578.9 ± 0.6	1.665 ± 0.147	13.70 ± 0.04	0.39 ± 0.04	190900	0.0012	0.041	2.520
Belinda	4.11E-09	40.3 ± 8	1.3	21.47 ± 0.09	0.07	75300	0.0001	0.031	0.624
Bianca	1.07E-09	25.7 ± 2	1.3	22.52 ± 0.24	0.07	59200	0.0009	0.193	0.435
Caliban	8.46E-09	49	1.5	22.42 ± 0.03	0.07	7231000	0.1587	140.881	579.73
Cordelia	5.18E-10	20.1 ± 3	1.3	23.62 ± 0.35	0.07	49800	0.0003	0.085	0.335
Cressida	3.95E-09	39.8 ± 2	1.3	21.58 ± 0.11	0.07	61800	0.0004	0.006	0.464
Desdemona	2.05E-09	32.0 ± 4	1.3	21.99 ± 0.16	0.07	62700	0.0001	0.113	0.474
Juliet	6.42E-09	46.8 ± 4	1.3	21.12 ± 0.05	0.07	64400	0.0007	0.065	0.493
Miranda	7.59E-07	235.8 ± 0.7	1.201 ± 0.137	15.79 ± 0.04	0.32 ± 0.03	129900	0.0013	4.338	1.413
Oberon	3.47E-05	761.4 ± 2.6	1.630 ± 0.043	13.70 ± 0.04	0.23 ± 0.03	583500	0.0014	0.068	13.46
Ophelia	6.21E-10	21.4 ± 4	1.3	23.26 ± 0.25	0.07	53800	0.0099	0.104	0.376
Portia	1.94E-08	67.6 ± 4	1.3	20.42 ± 0.05	0.07	66100	0.0001	0.059	0.513
Prospero	2.42E-10	15	1.5	23.2	0.07	16256000	0.4448	151.966	1978.29
Puck	3.33E-08	81 ± 2	1.3	19.75 ± 0.05	0.07	86000	0.0001	0.319	0.762
Rosalind	2.93E-09	36 ± 6	1.3	21.79 ± 0.13	0.07	69900	0.0001	0.279	0.558
Setebos	2.42E-10	15	1.5	23.3	0.07	17418000	0.5914	158.202	2225.21
Stephano	6.90E-11	10	1.5	24.1	0.07	8004000	0.2292	144.113	677.36
Sycorax	6.20E-08	95	1.5	20.82 ± 0.04	0.07	12179000	0.5224	159.404	1288.30
Titania	4.06E-05	788.9 ± 1.8	1.715 ± 0.044	13.49 ± 0.04	0.27 ± 0.03	436300	0.0011	0.079	8.706
Trinculo	8.63E-12	5	1.5	25.4	0.04	8504000	0.2200	167.050	749.24
Umbriel	1.35E-05	584.7 ± 2.8	1.400 ± 0.163	14.47 ± 0.04	0.21 ± 0.02	266000	0.0039	0.128	4.144
S/2001 U 2	1.55E-11	6	1.5	25.1	0.04	20901000	0.3682	169.840	2887.21
S/2001 U 3	1.55E-11	6	1.5	25.0	0.04	4276000	0.1459	145.220	266.56
S/2003 U 3	1.21E-11	5.5	1.5	25.2	0.04	14345000	0.6608	56.630	1687.01
NEPTUNE									
Despina	2.42E-08	75 ± 3	1.3	22.0	0.090	52526	0.0002	0.064	0.335
Galatea	4.31E-08	88 ± 4	1.3	21.8	0.079	61953	0.0000	0.062	0.429
Larissa	5.70E-08	97 ± 3	1.3	21.5	0.091	73548	0.0014	0.205	0.555
Naiad	2.24E-09	33 ± 3	1.3	23.9	0.072	48227	0.0004	4.746	0.294
Nereid	3.56E-07	170 ± 25	1.5	19.7	0.155	5513400	0.7512	7.232	360.14
Proteus	5.80E-07	210 ± 7	1.3	19.8	0.096	117647	0.0005	0.026	1.122
Thalassa	4.31E-09	41 ± 3	1.3	23.3	0.091	50075	0.0002	0.209	0.327
Triton	2.46E-04	1353.4 ± 0.9	2.061 ± 0.007	13.472 ± 0.041	0.756 ± 0.041	354800	0.0000	156.834	5.877
S/2002 N 1	1.04E-09	24	1.5	25.0	0.04	15728000	0.5711	134.101	1879.71
S/2002 N 2	1.04E-09	24	1.5	25.0	0.04	22422000	0.2931	48.511	2914.07
S/2002 N 3	1.04E-09	24	1.5	25.0	0.04	23571000	0.4237	34.741	3167.85
S/2002 N 4	1.90E-09	30	1.5	24.6	0.04	48387000	0.4945	132.585	9373.99
S/2003 N 1	1.73E-10	14	1.5	25.5	0.04	46695000	0.4499	137.391	9115.91
PLUTO									
Charon	0.123	593 ± 13	1.853 ± 0.158	17.26 ± 0.01	0.372 ± 0.012	19410	0.0002	99.089	6.387

Table column headings:	**$1/m_{pl}$**	Proportion of its planet's mass
	Mean radius	If no uncertainty is given, the value is computed from the magnitude and albedo
	Mean density	Derived from the GM and mean radius when an uncertainty is given, otherwise assumed
	Magnitude	Mean opposition magnitude: V_0, or red magnitude, R
	Geometric Albedo	Proportion of incident light reflected

a	Semi-major Axis (mean value)
e	Eccentricity (mean value)
i	Inclination with respect to the reference plane
P	Sidereal period (mean value)

Note 1:	Moons are listed in alphabetical order, except for those recently discovered.
Note 2:	Some data is unavailable owing to the relatively short time since the body was discovered
Note 3:	Scientific notation is used in order to save space. Eg. 1.66667E-08 is the 'computer notation' equivalent to 1.66667 x10^{-08} = 0.0000000166667
Note 4:	Moon names of the form S/2004 X 1 are only provisional. The S indicates a satellite of a planet (a moon), the next four digits indicate the year in which it was discovered, the X can have values J, S, U or N indicating the moon orbits either Jupiter, Saturn, Uranus or Neptune, respectively, and the last number indicates the order in which this moon was discovered if more than one was discovered for the planet in the given year.

Data from NASA/JPL (http://ssd.jpl.nasa.gov/)

Planet and satellite names

The naked eye planets were named in antiquity. But what about newly discovered moons and the geographical features revealed by spacecraft? A Commission of the International Astronomical Union (the organisation of professional astronomers) oversees and regulates naming. The rules are based on the needs of the astronomical community and reflect its international character and historical traditions. Planetary geographical features have Latin names. Latin is traditional, apolitical, and the closest thing to a universal language in history. The major rules are:

1. Nomenclature should be simple, clear, and unambiguous.
2. The number of names chosen for each body should be kept to a minimum, and their placement governed by the requirements of the scientific community.
3. Individual names chosen for each body should be expressed in the language of origin.
4. Where possible, the themes established in early Solar System nomenclature should be used and expanded on.
5. Solar System nomenclature should be international in its choice of names.
6. No names having political, military or religious significance may be used, except for names of political figures prior to the 19th century.
7. Features cannot be named after living people. Persons being so honoured must have been deceased for at least three years.
8. Features cannot be named for any religious figures from Christianity, Judaism, Islam, Hinduism, Buddhism or Confucianism.

MEANINGS OF PLANET AND SATELLITE NAMES

NAME	MEANING
Mercury	Named Mercurius by the Romans because it appears to move so swiftly.
Venus	Roman name for the goddess of love. This planet was considered to be the brightest and most beautiful planet or 'star' in the heavens. Other civilizations have named it for their god(ess) of love and/or war.
Earth	The name Earth comes from the Indo-European base 'er', which produced the Germanic noun 'ertho', and ultimately German 'erde', Dutch 'aarde', Danish and Swedish 'jord', and English 'earth'. Related forms include Greek 'eraze', meaning 'on the ground', and Welsh 'erw', meaning 'a piece of land'.
Moon	Every civilization has had a name for the satellite of Earth that is known, in English, as the Moon. The name is of Anglo-Saxon derivation. The Moon is known as Luna in Italian, Latin, and Spanish, as Lune in French, as Mond in German, and as Selene in Greek.
Mars	Named by the Romans for their god of war because of its red, bloodlike colour. Other civilizations also named this planet from this attribute; for example, the Egyptians named it 'Her Desher', meaning 'the red one'.
Phobos	Inner satellite of Mars. Named for one of the horses that drew Mars' chariot; also called attendant or son of Mars. Greek word means flight.
Deimos	Outer Martian satellite and named for one of Mars' horses/sons/ companions. Deimos means fear in Greek.
Jupiter	The largest and most massive of the planets was named Zeus by the Greeks and Jupiter by the Romans; he was the most important deity in both pantheons. Satellites in the Jovian system are named for Zeus/Jupiter's lovers and descendants.

Galileo discovered Io, Europa, Ganymede, and Callisto in 1610. Galileo suggested that the four be known as 'Medicea Sidera' to honour his patron, but the name was not accepted by other astronomers. Instead, they chose names given to the four satellites by Marius (who claimed to have discovered the Jovian satellites shortly before Galileo) in 1613; the names were of four of Jupiter's illicit loves. (Galileo refused to accept Marius' names; instead he identified the moons by Roman numerals, a secondary designation system that has been adopted for all satellite systems to the present.)

NAME	MEANING
Io	Io, the daughter of Inachus, was changed by Jupiter into a cow to protect her from Hera's jealous wrath. But Hera recognised Io and sent a gadfly to torment her. Io, maddened by the fly, wandered throughout the Mediterranean region.
Europa	Beautiful daughter of Agenor, king of Tyre, she was seduced by Jupiter, who had assumed the shape of a white bull. When Europa climbed on his back he swam with her to Crete, where she bore several children, including Minos.
Ganymede	Beautiful young boy who was carried to Olympus by Jupiter disguised as an eagle. Ganymede then became the cupbearer of the Olympian gods.
Callisto	Beautiful daughter of Lycaon, she was seduced by Jupiter, who changed her into a bear to protect her from Hera's jealousy.
Amalthea	A naiad (a goat in some accounts, a princess of Crete in others) who suckled Zeus (Jupiter) as a young child.
Himalia	A Rhodian nymph who bore three sons of Zeus.
Elara	Daughter of King Orchomenus, a paramour of Zeus, and the mother of the giant Tityus.
Pasiphaë	Wife of Minos, mother of the Minotaur.
Sinope	Daughter of the river god Asopus and Merope, she was abducted by Apollo.
Lysithea	Daughter of Kadmos, also named Semele, mother of Dionysos by Zeus. According to others, she was the daughter of Evenus and mother of Helenus by Jupiter.
Carme	A nymph and attendant of Artemis; mother, by Zeus, of Britomartis.
Ananke	Goddess of fate and necessity, mother of Adrastea by Zeus.
Leda	Seduced by Zeus in the form of a swan, she was the mother of Pollux and Helen.
Thebe	A nymph abducted by Zeus, she is the namesake of the Greek city of Thebes.
Adrastea	A nymph of Crete to whose care Rhea entrusted the infant Zeus.
Metis	First wife of Zeus. He swallowed her when she became pregnant; Athena was subsequently born from the forehead of Zeus.
Callirrhoe	A daughter of the river god Achelous, wife of Alcmaeon who lost the war for Thebes.
Themisto	Wife of Athamas, King of Thebes. She tried to kill Ino's children, but killed her own by mistake. There is also another Themisto who was involved in a love affair with Zeus.
Megaclite	Daughter of Macareus, who with Zeus gave birth to Thebe and Locrus.
Taygete	One of the Greek Pleiades. Daughter of Atlas, mother of Lacedaemon by Zeus.
Chaldene	Bore the son Solymos with Zeus.
Harpalyke	Daughter and wife of Clymenus. In revenge for this incestuous relationship, she killed the son she bore him, cooked the corpse, and served it to Clymenus. She was transformed into the night bird called Chalkis, and Clymenus hanged himself.
Kalyke	Nymph who bore the handsome son Endymion with Zeus.
Iocaste	Wife of Laius, King of Thebes, and mother of Oedipus. After Laius was killed, Iocaste unknowingly married her own son Oedipus. When she learned that her husband was her son, she killed herself.
Erinome	Daughter of Celes, compelled by Venus to fall in love with Zeus.
Isonoe	A Danaid who bore with Zeus the son Orchomenos or Chrysen.
Praxidike	Greek goddess of punishment of evil actions, justice, and of retribution.
Autonoe	Mother of the Graces by Zeus, according to some authorities.
Thyone	Semele, mother of Dionysos by Zeus. She received the name of Thyone in Hades by Dionysos before he ascended up with her from there to heaven.
Hermippe	Consort of Zeus and mother of Orchomenos by him.
Aitne	A Sicilian nymph and lover of Zeus.
Eurydome	Mother of the Graces by Zeus, according to some authorities.
Euanthe	Mother of the Graces by Zeus, according to some authorities.
Euporie	One of the Horae (seasons), a daughter of Jupiter and Themis.

MEANINGS OF PLANET AND SATELLITE NAMES

NAME	MEANING
Orthosie	One of the Horae (seasons), a daughter of Jupiter and Themis.
Sponde	One of the Horae (seasons), daughter of Jupiter.
Kale	One of the Graces, a daughter of Zeus, husband of Hephaistos.
Pasithee	One of the Graces, a daughter of Zeus.
Saturn	Roman name for the Greek Cronos, father of Zeus/Jupiter. Other civilizations have given other names to Saturn, which is the farthest planet from Earth that can be observed by the naked human eye. Most of its satellites were named for Titans who, according to Greek mythology, were brothers and sisters of Saturn. In Greek mythology, the Titans were a race of godlike giants who were considered to be the personifications of the forces of nature. They were the twelve children (six sons and six daughters) of Gaia and Uranus. Satellites in the Saturnian system are named for Greco-Roman Titans, descendants of the Titans, the Roman god of the beginning, and giants from Greco-Roman and other mythologies. Gallic, Inuit and Norse names identify three different orbit inclination groups.
Mimas	Named for a Titan felled by Hephaestus (or Ares) in the war between the Titans and Olympian gods.
Enceladus	The Giant Enceladus was crushed by Athene in the battle between the Olympian gods and the Titans. Earth piled on top of him became the island of Sicily.
Tethys	Tethys was the wife of Oceanus and mother of all rivers and Oceanids.
Dione	Dione was the sister of Cronos and mother (by Zeus) of Aphrodite.
Rhea	Daughter of Cronos and mother of Zeus.
Titan	Discovered and named in 1655 by C. Huygens, who first called it 'Luna Saturni'.
Hyperion	A Titan who married his sister Theia and has three children – Helios, Selene and Eos.
Iapetus	A Titan whose wife was Clymene, with whom he had four children – Atlas, Menoetius, Prometheus and Epimetheus.
Phoebe	She married her brother Coeus and was the mother of Leto and Asteria. It is said that she owned the oracle of Delphi before Apollo took it over.
Janus	Named for the two-faced Roman god who could look forward and backward at the same time. Shares the same orbit with Epimetheus but they never actually collide.
Epimetheus	Named for the Greek backward-looking god. Shares the same orbit Janus but they never actually collide.
Helene	The daughter of Tityrus, and one of the Amazons. A granddaughter of Kronos, for her beauty she triggered off the Trojan War
Telesto	One of 3,000 Oceanides, water nymphs born to Oceanus and Tethys.
Calypso	Daughter of the Titans Oceanus and Tethys and paramour of Odysseus.
Atlas	Held the heavens on his shoulders.
Prometheus	Son of the Titan Iapetus, brother of Atlas and Epimetheus, he gave many gifts to humanity, including fire which he stole from Zeus and the gods.
Pandora	Made of clay by Hephaestus at the request of Zeus. She married Epimetheus and opened the box that loosed a host of plagues upon humanity.
Pan	Son of the Titan Kronos and Rhea. He was half human, half goat – god of pastoralism.
Ymir	Ymir is the primordial Norse giant and the progenitor of the race of frost giants.
Paaliaq	An Inuit giant.
Tarvos	A Gallic giant.
Ijiraq	An Inuit giant.
Suttungr	Named for a Norse giant who kindled flames that destroyed the world.
Kiviuq	An Inuit giant.
Mundilfari	In Norse myth, there was once a giant named Mundilfari who was married to Glaur. Their children were so beautiful that he named his son Mani (Moon) and his daughter Sol (Sun).
Albiorix	'King of the world'. An alternative name of the Gallic god Teutates. He is the god of war, fertility, and wealth.
Skathi	A giantess, called the 'snow-shoe goddess', and the embodiment of winter. She is the wife of the god Njord.
Erriapo	A Gallic giant.
Siarnaq	An Inuit giant.
Thrymr	Named for a Norse giant.
Uranus	Uranus was discovered by William Herschel in 1781. Several astronomers, including Flamsteed and Le Monnier, had observed it earlier but had recorded it as a fixed star. Herschel tried unsuccessfully to name his discovery 'Georgian Sidus' after George III; the planet was named by Johann Bode in 1781 for the father of Saturn. Uranus is the only body in the Solar System with moons not named from classical mythology – its moons are named from works by Shakespeare and Alexander Pope. Any future satellites will follow that naming convention.
Ariel	A sylph in Pope's 'Rape of the Lock'.
Umbriel	A malevolent spirit in Pope's 'Rape of the Lock'.
Titania	Queen of the fairies in Shakespeare's 'A Midsummer Night's Dream'.
Oberon	King of the fairies in Shakespeare's 'A Midsummer Night's Dream'.
Miranda	Heroine of Shakespeare's 'The Tempest'.
Cordelia	Daughter of Lear in Shakespeare's 'King Lear'.
Ophelia	Daughter of Polonius, fiance of Hamlet in Shakespeare's 'Hamlet, Prince of Denmark'.
Bianca	Daughter of Baptista, sister of Kate in Shakespeare's 'Taming of the Shrew'.
Cressida	Title character in Shakespeare's 'Troilus and Cressida'.
Desdemona	Wife of Othello in Shakespeare's 'Othello, the Moor of Venice'.
Juliet	Heroine of Shakespeare's 'Romeo and Juliet'.
Portia	Wife of Brutus in Shakespeare's 'Julius Caesar'.
Rosalind	Daughter of the banished duke in Shakespeare's 'As You Like It'.
Belinda	Character in Pope's 'Rape of the Lock'.
Puck	Mischievous spirit in Shakespeare's 'A Midsummer Night's Dream'.
Caliban	Named for the grotesque, brutish slave in Shakespeare's 'The Tempest'.
Sycorax	Named for Caliban's mother in Shakespeare's 'The Tempest'.
Prospero	Named for the rightful Duke of Milan in 'The Tempest'.
Setebos	Setebos was a new-world (South American) deity's name that Shakespeare popularised as Sycorax's god in 'The Tempest'.
Stephano	Named for a drunken butler in 'The Tempest'.
Trinculo	Trinculo is an entertainer without an audience in 'The Tempest'.
Neptune	Neptune was actually 'observed' as early as 1690 by John Flamsteed, who thought it was a fixed star. It was 'predicted' by John Couch Adams and Urbain Le Verrier who, independently, were able to account for the irregularities in the motion of Uranus by correctly predicting the orbital elements of a trans-Uranian body. Using the predicted parameters of Le Verrier (Adams never published his predictions), Johann Galle observed the planet in 1846. Galle wanted to name the planet for Le Verrier, but that was not acceptable to the international astronomical community. Instead, this planet is named for the Roman god of the sea. Satellites in the Neptunian system are named for characters from Greek or Roman mythology associated with Neptune /Poseidon or the oceans.
Triton	Triton is named for the sea-god son of Poseidon (Neptune) and Amphitrite.
Nereid	The Nereids were the fifty daughters of Nereus and Doris and were attendants of Neptune.
Naiad	The name of a group of Greek water nymphs who were guardians of lakes, fountains, springs and rivers.
Thalassa	Greek sea goddess. Mother of Aphrodite in some legends; others say she bore the Telchines.
Despina	Daughter of Poseidon (Neptune) and Demeter.
Galatea	One of the Nereids, attendants of Poseidon.
Larissa	A lover of Poseidon.
Proteus	Greek sea god, son of Oceanus and Tethys.
Pluto	Discovered in 1930 by American astronomer Clyde W. Tombaugh at Lowell Observatory in Flagstaff, Arizona, during a systematic search for a trans-Neptune planet predicted by Percival Lowell and William H. Pickering. Named after Greek god of the underworld who was able to render himself invisible.
Charon	Discovered in 1978 by James W. Christy. Named after the mythological boatman who ferried souls across the river Styx to Pluto for judgement.

GEOCENTRIC POSITION OF SUN (EPOCH J2000.0)

Note: positions refer to 0000 WAST

MONTH	DAY	RA			DECLINATION			DISTANCE (AU)
		h	m	s	°	′	″	
January	**1**	**18**	**44**	**23.1**	**-23**	**02**	**47**	**0.983**
Jan	2	18	48	48.0	-22	57	53	0.983
Jan	3	18	53	12.5	-22	52	31	0.983
Jan	4	18	57	36.7	-22	46	41	0.983
Jan	5	19	02	00.5	-22	40	25	0.983
Jan	6	19	06	23.9	-22	33	42	0.983
Jan	7	19	10	46.9	-22	26	31	0.983
Jan	8	19	15	09.4	-22	18	54	0.983
Jan	9	19	19	31.5	-22	10	51	0.983
Jan	10	19	23	53.0	-22	02	22	0.983
Jan	11	19	28	14.0	-21	53	27	0.983
Jan	12	19	32	34.4	-21	44	06	0.984
Jan	13	19	36	54.2	-21	34	19	0.984
Jan	14	19	41	13.4	-21	24	08	0.984
Jan	15	19	45	31.9	-21	13	32	0.984
Jan	16	19	49	49.7	-21	02	31	0.984
Jan	17	19	54	06.8	-20	51	07	0.984
Jan	18	19	58	23.2	-20	39	18	0.984
Jan	19	20	02	38.9	-20	27	06	0.984
Jan	20	20	06	53.8	-20	14	32	0.984
Jan	21	20	11	08.0	-20	01	34	0.984
Jan	22	20	15	21.4	-19	48	14	0.984
Jan	23	20	19	34.0	-19	34	32	0.984
Jan	24	20	23	45.9	-19	20	28	0.984
Jan	25	20	27	57.0	-19	06	03	0.984
Jan	26	20	32	07.2	-18	51	16	0.985
Jan	27	20	36	16.7	-18	36	10	0.985
Jan	28	20	40	25.4	-18	20	43	0.985
Jan	29	20	44	33.2	-18	04	56	0.985
Jan	30	20	48	40.3	-17	48	50	0.985
Jan	31	20	52	46.6	-17	32	24	0.985
February	**1**	**20**	**56**	**52.0**	**-17**	**15**	**40**	**0.985**
Feb	2	21	00	56.7	-16	58	37	0.985
Feb	3	21	05	00.6	-16	41	17	0.986
Feb	4	21	09	03.6	-16	23	39	0.986
Feb	5	21	13	05.9	-16	05	44	0.986
Feb	6	21	17	07.4	-15	47	32	0.986
Feb	7	21	21	08.1	-15	29	03	0.986
Feb	8	21	25	08.0	-15	10	19	0.986
Feb	9	21	29	07.2	-14	51	19	0.987
Feb	10	21	33	05.5	-14	32	05	0.987
Feb	11	21	37	03.0	-14	12	35	0.987
Feb	12	21	40	59.8	-13	52	52	0.987
Feb	13	21	44	55.8	-13	32	54	0.987
Feb	14	21	48	51.0	-13	12	44	0.987
Feb	15	21	52	45.5	-12	52	20	0.988
Feb	16	21	56	39.2	-12	31	45	0.988
Feb	17	22	00	32.2	-12	10	57	0.988
Feb	18	22	04	24.5	-11	49	58	0.988
Feb	19	22	08	16.0	-11	28	47	0.988
Feb	20	22	12	06.9	-11	07	26	0.989
Feb	21	22	15	57.1	-10	45	55	0.989
Feb	22	22	19	46.6	-10	24	14	0.989
Feb	23	22	23	35.5	-10	02	23	0.989
Feb	24	22	27	23.7	-09	40	23	0.990
Feb	25	22	31	11.4	-09	18	14	0.990
Feb	26	22	34	58.4	-08	55	57	0.990
Feb	27	22	38	44.9	-08	33	32	0.990
Feb	28	22	42	30.9	-08	10	59	0.990
March	**1**	**22**	**46**	**16.3**	**-07**	**48**	**19**	**0.991**
Mar	2	22	50	01.2	-07	25	32	0.991
Mar	3	22	53	45.7	-07	02	39	0.991
Mar	4	22	57	29.7	-06	39	40	0.991
Mar	5	23	01	13.2	-06	16	34	0.992
Mar	6	23	04	56.3	-05	53	24	0.992
Mar	7	23	08	39.0	-05	30	08	0.992
Mar	8	23	12	21.3	-05	06	48	0.993
Mar	9	23	16	03.3	-04	43	24	0.993
Mar	10	23	19	44.8	-04	19	56	0.993
Mar	11	23	23	26.1	-03	56	25	0.993
Mar	12	23	27	07.0	-03	32	51	0.994
Mar	13	23	30	47.6	-03	09	14	0.994
Mar	14	23	34	27.9	-02	45	35	0.994
Mar	15	23	38	07.9	-02	21	55	0.994
Mar	16	23	41	47.7	-01	58	13	0.995
Mar	17	23	45	27.2	-01	34	30	0.995
Mar	18	23	49	06.5	-01	10	47	0.995
Mar	19	23	52	45.6	-00	47	04	0.995
Mar	20	23	56	24.5	-00	23	21	0.996
Mar	21	00	00	03.3	+00	00	22	0.996
Mar	22	00	03	41.9	+00	24	04	0.996
Mar	23	00	07	20.5	+00	47	44	0.997
Mar	24	00	10	58.9	+01	11	23	0.997
Mar	25	00	14	37.2	+01	34	60	0.997
Mar	26	00	18	15.6	+01	58	34	0.997
Mar	27	00	21	53.9	+02	22	06	0.998
Mar	28	00	25	32.1	+02	45	35	0.998
Mar	29	00	29	10.5	+03	09	01	0.998
Mar	30	00	32	48.8	+03	32	23	0.999
Mar	31	00	36	27.3	+03	55	41	0.999
April	**1**	**00**	**40**	**05.8**	**+04**	**18**	**55**	**0.999**
Apr	2	00	43	44.4	+04	42	05	0.999
Apr	3	00	47	23.2	+05	05	09	1.000
Apr	4	00	51	02.2	+05	28	09	1.000
Apr	5	00	54	41.3	+05	51	02	1.000
Apr	6	00	58	20.5	+06	13	50	1.001
Apr	7	01	02	00.0	+06	36	31	1.001
Apr	8	01	05	39.8	+06	59	06	1.001
Apr	9	01	09	19.7	+07	21	33	1.001
Apr	10	01	12	59.9	+07	43	53	1.002
Apr	11	01	16	40.3	+08	06	06	1.002
Apr	12	01	20	21.1	+08	28	10	1.002
Apr	13	01	24	02.1	+08	50	05	1.003
Apr	14	01	27	43.4	+09	11	52	1.003
Apr	15	01	31	25.0	+09	33	29	1.003
Apr	16	01	35	07.0	+09	54	56	1.003
Apr	17	01	38	49.3	+10	16	14	1.004
Apr	18	01	42	31.9	+10	37	21	1.004
Apr	19	01	46	14.9	+10	58	18	1.004
Apr	20	01	49	58.3	+11	19	04	1.005
Apr	21	01	53	42.2	+11	39	38	1.005
Apr	22	01	57	26.4	+12	00	01	1.005
Apr	23	02	01	11.0	+12	20	12	1.005
Apr	24	02	04	56.2	+12	40	11	1.006
Apr	25	02	08	41.7	+12	59	57	1.006
Apr	26	02	12	27.8	+13	19	31	1.006
Apr	27	02	16	14.3	+13	38	51	1.006
Apr	28	02	20	01.4	+13	57	58	1.007
Apr	29	02	23	48.9	+14	16	51	1.007
Apr	30	02	27	37.0	+14	35	30	1.007
May	**1**	**02**	**31**	**25.6**	**+14**	**53**	**55**	**1.007**
May	2	02	35	14.8	+15	12	06	1.008

GEOCENTRIC POSITION OF SUN (continued)

Note: positions refer to 0000 WAST

MONTH	DAY	RA			DECLINATION			DISTANCE (AU)
		h	m	s	°	′	″	
May	3	02	39	04.6	+15	30	01	1.008
May	4	02	42	54.9	+15	47	41	1.008
May	5	02	46	45.8	+16	05	06	1.008
May	6	02	50	37.2	+16	22	14	1.009
May	7	02	54	29.3	+16	39	06	1.009
May	8	02	58	21.9	+16	55	42	1.009
May	9	03	02	15.0	+17	12	01	1.009
May	10	03	06	08.8	+17	28	02	1.010
May	11	03	10	03.1	+17	43	46	1.010
May	12	03	13	58.0	+17	59	12	1.010
May	13	03	17	53.4	+18	14	20	1.010
May	14	03	21	49.4	+18	29	09	1.011
May	15	03	25	46.0	+18	43	39	1.011
May	16	03	29	43.1	+18	57	51	1.011
May	17	03	33	40.7	+19	11	43	1.011
May	18	03	37	38.9	+19	25	15	1.011
May	19	03	41	37.6	+19	38	28	1.012
May	20	03	45	36.9	+19	51	20	1.012
May	21	03	49	36.7	+20	03	53	1.012
May	22	03	53	37.0	+20	16	04	1.012
May	23	03	57	37.9	+20	27	55	1.012
May	24	04	01	39.2	+20	39	25	1.013
May	25	04	05	41.1	+20	50	33	1.013
May	26	04	09	43.5	+21	01	20	1.013
May	27	04	13	46.3	+21	11	45	1.013
May	28	04	17	49.7	+21	21	49	1.013
May	29	04	21	53.5	+21	31	30	1.013
May	30	04	25	57.8	+21	40	49	1.014
May	31	04	30	02.6	+21	49	46	1.014
June	**1**	**04**	**34**	**07.8**	**+21**	**58**	**20**	**1.014**
Jun	2	04	38	13.4	+22	06	31	1.014
Jun	3	04	42	19.5	+22	14	18	1.014
Jun	4	04	46	25.9	+22	21	43	1.014
Jun	5	04	50	32.7	+22	28	44	1.015
Jun	6	04	54	39.9	+22	35	22	1.015
Jun	7	04	58	47.4	+22	41	36	1.015
Jun	8	05	02	55.2	+22	47	25	1.015
Jun	9	05	07	03.2	+22	52	51	1.015
Jun	10	05	11	11.5	+22	57	53	1.015
Jun	11	05	15	20.1	+23	02	30	1.015
Jun	12	05	19	28.8	+23	06	43	1.015
Jun	13	05	23	37.7	+23	10	32	1.016
Jun	14	05	27	46.8	+23	13	55	1.016
Jun	15	05	31	56.0	+23	16	55	1.016
Jun	16	05	36	05.4	+23	19	29	1.016
Jun	17	05	40	14.8	+23	21	39	1.016
Jun	18	05	44	24.2	+23	23	25	1.016
Jun	19	05	48	33.7	+23	24	45	1.016
Jun	20	05	52	43.3	+23	25	41	1.016
Jun	21	05	56	52.8	+23	26	12	1.016
Jun	22	06	01	02.3	+23	26	18	1.016
Jun	23	06	05	11.7	+23	25	59	1.016
Jun	24	06	09	21.1	+23	25	16	1.016
Jun	25	06	13	30.4	+23	24	08	1.016
Jun	26	06	17	39.7	+23	22	35	1.016
Jun	27	06	21	48.8	+23	20	38	1.017
Jun	28	06	25	57.7	+23	18	16	1.017
Jun	29	06	30	06.6	+23	15	29	1.017
Jun	30	06	34	15.2	+23	12	18	1.017
July	**1**	**06**	**38**	**23.7**	**+23**	**08**	**43**	**1.017**
Jul	2	06	42	31.9	+23	04	43	1.017
Jul	3	06	46	39.8	+23	00	19	1.017
Jul	4	06	50	47.5	+22	55	31	1.017
Jul	5	06	54	54.9	+22	50	19	1.017
Jul	6	06	59	02.0	+22	44	43	1.017
Jul	7	07	03	08.8	+22	38	43	1.017
Jul	8	07	07	15.1	+22	32	20	1.017
Jul	9	07	11	21.1	+22	25	33	1.017
Jul	10	07	15	26.7	+22	18	23	1.017
Jul	11	07	19	31.8	+22	10	50	1.017
Jul	12	07	23	36.5	+22	02	54	1.017
Jul	13	07	27	40.7	+21	54	36	1.017
Jul	14	07	31	44.4	+21	45	55	1.017
Jul	15	07	35	47.7	+21	36	51	1.016
Jul	16	07	39	50.4	+21	27	26	1.016
Jul	17	07	43	52.6	+21	17	38	1.016
Jul	18	07	47	54.2	+21	07	29	1.016
Jul	19	07	51	55.3	+20	56	59	1.016
Jul	20	07	55	55.9	+20	46	08	1.016
Jul	21	07	59	55.9	+20	34	55	1.016
Jul	22	08	03	55.3	+20	23	22	1.016
Jul	23	08	07	54.1	+20	11	29	1.016
Jul	24	08	11	52.4	+19	59	15	1.016
Jul	25	08	15	50.1	+19	46	41	1.016
Jul	26	08	19	47.3	+19	33	48	1.016
Jul	27	08	23	43.8	+19	20	35	1.016
Jul	28	08	27	39.8	+19	07	03	1.015
Jul	29	08	31	35.2	+18	53	12	1.015
Jul	30	08	35	30.1	+18	39	02	1.015
Jul	31	08	39	24.3	+18	24	33	1.015
August	**1**	**08**	**43**	**17.9**	**+18**	**09**	**47**	**1.015**
Aug	2	08	47	11.0	+17	54	42	1.015
Aug	3	08	51	03.4	+17	39	20	1.015
Aug	4	08	54	55.3	+17	23	41	1.015
Aug	5	08	58	46.5	+17	07	45	1.015
Aug	6	09	02	37.2	+16	51	31	1.014
Aug	7	09	06	27.2	+16	35	02	1.014
Aug	8	09	10	16.7	+16	18	17	1.014
Aug	9	09	14	05.5	+16	01	16	1.014
Aug	10	09	17	53.8	+15	43	59	1.014
Aug	11	09	21	41.5	+15	26	27	1.014
Aug	12	09	25	28.6	+15	08	41	1.013
Aug	13	09	29	15.1	+14	50	40	1.013
Aug	14	09	33	01.0	+14	32	25	1.013
Aug	15	09	36	46.4	+14	13	57	1.013
Aug	16	09	40	31.2	+13	55	15	1.013
Aug	17	09	44	15.4	+13	36	20	1.012
Aug	18	09	47	59.2	+13	17	11	1.012
Aug	19	09	51	42.4	+12	57	51	1.012
Aug	20	09	55	25.1	+12	38	18	1.012
Aug	21	09	59	07.3	+12	18	33	1.012
Aug	22	10	02	49.1	+11	58	37	1.011
Aug	23	10	06	30.4	+11	38	29	1.011
Aug	24	10	10	11.3	+11	18	10	1.011
Aug	25	10	13	51.8	+10	57	40	1.011
Aug	26	10	17	31.9	+10	36	60	1.011
Aug	27	10	21	11.6	+10	16	09	1.010
Aug	28	10	24	50.9	+09	55	09	1.010
Aug	29	10	28	29.9	+09	33	59	1.010
Aug	30	10	32	08.5	+09	12	40	1.010
Aug	31	10	35	46.8	+08	51	12	1.010
September	**1**	**10**	**39**	**24.8**	**+08**	**29**	**35**	**1.009**

GEOCENTRIC POSITION OF SUN (continued)

MONTH	DAY	RA			DECLINATION			DISTANCE (AU)
		h	m	s	°	′	″	
Sep	2	10	43	02.4	+08	07	50	1.009
Sep	3	10	46	39.8	+07	45	57	1.009
Sep	4	10	50	17.0	+07	23	57	1.009
Sep	5	10	53	53.8	+07	01	49	1.008
Sep	6	10	57	30.5	+06	39	34	1.008
Sep	7	11	01	06.9	+06	17	13	1.008
Sep	8	11	04	43.0	+05	54	46	1.008
Sep	9	11	08	19.0	+05	32	13	1.007
Sep	10	11	11	54.9	+05	09	34	1.007
Sep	11	11	15	30.5	+04	46	51	1.007
Sep	12	11	19	06.0	+04	24	02	1.007
Sep	13	11	22	41.4	+04	01	09	1.006
Sep	14	11	26	16.7	+03	38	12	1.006
Sep	15	11	29	51.9	+03	15	12	1.006
Sep	16	11	33	27.0	+02	52	07	1.005
Sep	17	11	37	02.1	+02	28	60	1.005
Sep	18	11	40	37.2	+02	05	50	1.005
Sep	19	11	44	12.2	+01	42	37	1.005
Sep	20	11	47	47.4	+01	19	22	1.004
Sep	21	11	51	22.5	+00	56	04	1.004
Sep	22	11	54	57.8	+00	32	46	1.004
Sep	23	11	58	33.1	+00	09	26	1.004
Sep	24	12	02	08.6	-00	13	56	1.003
Sep	25	12	05	44.3	-00	37	18	1.003
Sep	26	12	09	20.1	-01	00	40	1.003
Sep	27	12	12	56.1	-01	24	02	1.002
Sep	28	12	16	32.3	-01	47	24	1.002
Sep	29	12	20	08.7	-02	10	46	1.002
Sep	30	12	23	45.4	-02	34	06	1.002
October	**1**	**12**	**27**	**22.3**	**-02**	**57**	**25**	**1.001**
Oct	2	12	30	59.5	-03	20	42	1.001
Oct	3	12	34	37.1	-03	43	57	1.001
Oct	4	12	38	14.9	-04	07	09	1.000
Oct	5	12	41	53.1	-04	30	19	1.000
Oct	6	12	45	31.6	-04	53	25	1.000
Oct	7	12	49	10.5	-05	16	27	1.000
Oct	8	12	52	49.8	-05	39	26	0.999
Oct	9	12	56	29.5	-06	02	19	0.999
Oct	10	13	00	09.6	-06	25	08	0.999
Oct	11	13	03	50.2	-06	47	52	0.998
Oct	12	13	07	31.2	-07	10	30	0.998
Oct	13	13	11	12.7	-07	33	03	0.998
Oct	14	13	14	54.7	-07	55	29	0.998
Oct	15	13	18	37.2	-08	17	48	0.997
Oct	16	13	22	20.2	-08	39	60	0.997
Oct	17	13	26	03.8	-09	02	04	0.997
Oct	18	13	29	47.9	-09	24	01	0.996
Oct	19	13	33	32.7	-09	45	50	0.996
Oct	20	13	37	18.1	-10	07	30	0.996
Oct	21	13	41	04.1	-10	29	02	0.996
Oct	22	13	44	50.8	-10	50	24	0.995
Oct	23	13	48	38.2	-11	11	37	0.995
Oct	24	13	52	26.2	-11	32	40	0.995
Oct	25	13	56	15.0	-11	53	32	0.994
Oct	26	14	00	04.5	-12	14	14	0.994
Oct	27	14	03	54.7	-12	34	45	0.994
Oct	28	14	07	45.7	-12	55	04	0.994
Oct	29	14	11	37.5	-13	15	11	0.993
Oct	30	14	15	30.0	-13	35	05	0.993
Oct	31	14	19	23.3	-13	54	47	0.993
November	**1**	**14**	**23**	**17.4**	**-14**	**14**	**16**	**0.993**
Nov	2	14	27	12.3	-14	33	31	0.992
Nov	3	14	31	08.0	-14	52	32	0.992
Nov	4	14	35	04.5	-15	11	18	0.992
Nov	5	14	39	01.9	-15	29	49	0.992
Nov	6	14	42	60.0	-15	48	05	0.991
Nov	7	14	46	58.9	-16	06	05	0.991
Nov	8	14	50	58.7	-16	23	49	0.991
Nov	9	14	54	59.3	-16	41	16	0.991
Nov	10	14	59	00.7	-16	58	27	0.990
Nov	11	15	03	03.0	-17	15	19	0.990
Nov	12	15	07	06.1	-17	31	54	0.990
Nov	13	15	11	10.0	-17	48	11	0.990
Nov	14	15	15	14.7	-18	04	09	0.989
Nov	15	15	19	20.3	-18	19	48	0.989
Nov	16	15	23	26.7	-18	35	08	0.989
Nov	17	15	27	34.0	-18	50	09	0.989
Nov	18	15	31	42.1	-19	04	49	0.989
Nov	19	15	35	51.0	-19	19	09	0.988
Nov	20	15	40	00.8	-19	33	08	0.988
Nov	21	15	44	11.4	-19	46	46	0.988
Nov	22	15	48	22.8	-20	00	02	0.988
Nov	23	15	52	35.0	-20	12	57	0.988
Nov	24	15	56	48.1	-20	25	29	0.987
Nov	25	16	01	01.9	-20	37	39	0.987
Nov	26	16	05	16.5	-20	49	26	0.987
Nov	27	16	09	31.9	-21	00	50	0.987
Nov	28	16	13	48.1	-21	11	50	0.987
Nov	29	16	18	04.9	-21	22	26	0.987
Nov	30	16	22	22.5	-21	32	38	0.986
December	**1**	**16**	**26**	**40.8**	**-21**	**42**	**26**	**0.986**
Dec	2	16	30	59.7	-21	51	48	0.986
Dec	3	16	35	19.3	-22	00	46	0.986
Dec	4	16	39	39.4	-22	09	17	0.986
Dec	5	16	44	00.2	-22	7	23	0.986
Dec	6	16	48	21.5	-22	25	04	0.985
Dec	7	16	52	43.3	-22	32	17	0.985
Dec	8	16	57	05.7	-22	39	05	0.985
Dec	9	17	01	28.5	-22	45	25	0.985
Dec	10	17	05	51.7	-22	51	19	0.985
Dec	11	17	10	15.3	-22	56	46	0.985
Dec	12	17	14	39.4	-23	01	46	0.985
Dec	13	17	19	03.8	-23	06	18	0.984
Dec	14	17	23	28.5	-23	10	22	0.984
Dec	15	17	27	53.5	-23	13	60	0.984
Dec	16	17	32	18.8	-23	17	09	0.984
Dec	17	17	36	44.3	-23	19	50	0.984
Dec	18	17	41	10.0	-23	22	04	0.984
Dec	19	17	45	36.0	-23	23	50	0.984
Dec	20	17	50	02.1	-23	25	07	0.984
Dec	21	17	54	28.3	-23	25	56	0.984
Dec	22	17	58	54.6	-23	26	18	0.984
Dec	23	18	03	21.0	-23	26	11	0.984
Dec	24	18	07	47.3	-23	25	35	0.984
Dec	25	18	12	13.7	-23	24	32	0.984
Dec	26	18	16	40.1	-23	22	60	0.984
Dec	27	18	21	06.4	-23	20	60	0.983
Dec	28	18	25	32.5	-23	18	32	0.983
Dec	29	18	29	58.5	-23	15	35	0.983
Dec	30	18	34	24.4	-23	12	11	0.983
Dec	31	18	38	50.0	-23	08	19	0.983

GEOCENTRIC POSITION OF MOON (EPOCH J2000.0)

Note: positions refer to 0000 WAST

MONTH	DAY	RA			DECLINATION			DISTANCE (1,000 km)
		h	m	s	°	′	″	
January	**1**	**10**	**31**	**19.5**	**+13**	**42**	**08**	**400.9**
Jan	2	11	16	00.0	+08	24	49	397.3
Jan	3	12	00	15.2	+02	42	38	392.8
Jan	4	12	45	09.4	-03	14	02	387.5
Jan	5	13	31	55.9	-09	13	13	381.6
Jan	6	14	21	53.9	-14	59	32	375.4
Jan	7	15	16	19.7	-20	12	27	369.4
Jan	8	16	16	05.0	-24	25	28	364.0
Jan	9	17	21	00.3	-27	08	26	359.8
Jan	10	18	29	21.1	-27	55	09	357.2
Jan	11	19	38	01.1	-26	34	05	356.6
Jan	12	20	43	49.7	-23	14	34	358.0
Jan	13	21	44	53.5	-18	22	49	361.2
Jan	14	22	40	56.1	-12	31	28	366.0
Jan	15	23	32	46.1	-06	10	51	371.7
Jan	16	00	21	39.1	+00	14	44	378.0
Jan	17	01	08	54.7	+06	26	55	384.2
Jan	18	01	55	45.8	+12	11	44	390.0
Jan	19	02	43	13.3	+17	17	41	395.0
Jan	20	03	32	02.4	+21	34	22	399.2
Jan	21	04	22	36.1	+24	51	60	402.4
Jan	22	05	14	49.7	+27	01	40	404.6
Jan	23	06	08	08.5	+27	56	41	406.0
Jan	24	07	01	35.1	+27	34	07	406.5
Jan	25	07	54	06.1	+25	55	48	406.2
Jan	26	08	44	51.8	+23	08	07	405.4
Jan	27	09	33	28.7	+19	20	44	403.9
Jan	28	10	20	01.6	+14	44	56	401.8
Jan	29	11	04	58.6	+09	32	21	399.2
Jan	30	11	49	04.6	+03	54	21	396.0
Jan	31	12	33	15.9	-01	57	49	392.2
February	**1**	**13**	**18**	**37.8**	**-07**	**52**	**19**	**387.7**
Feb	2	14	06	21.6	-13	35	34	382.8
Feb	3	14	57	40.0	-18	50	46	377.6
Feb	4	15	53	33.9	-23	16	43	372.3
Feb	5	16	54	27.8	-26	28	11	367.4
Feb	6	17	59	36.5	-27	59	30	363.1
Feb	7	19	06	51.5	-27	32	15	360.1
Feb	8	20	13	18.3	-25	03	26	358.7
Feb	9	21	16	30.2	-20	48	04	359.0
Feb	10	22	15	20.5	-15	13	44	361.2
Feb	11	23	09	59.0	-08	52	06	365.1
Feb	12	00	01	20.9	-02	12	26	370.2
Feb	13	00	50	37.9	+04	21	15	376.2
Feb	14	01	39	01.5	+10	30	16	382.5
Feb	15	02	27	33.9	+16	00	07	388.6
Feb	16	03	17	02.8	+20	39	09	394.1
Feb	17	04	07	56.0	+24	17	29	398.7
Feb	18	05	00	15.8	+26	46	50	402.2
Feb	19	05	53	36.8	+28	01	06	404.5
Feb	20	06	47	10.5	+27	57	20	405.7
Feb	21	07	39	60.0	+26	36	42	405.8
Feb	22	08	31	16.6	+24	04	22	404.9
Feb	23	09	20	33.5	+20	28	51	403.4
Feb	24	10	07	49.8	+16	00	40	401.2
Feb	25	10	53	27.1	+10	51	22	398.5
Feb	26	11	38	04.0	+05	12	55	395.6
Feb	27	12	22	30.6	-00	42	24	392.4
Feb	28	13	07	45.0	-06	41	38	389.0
March	**1**	**13**	**54**	**50.8**	**-12**	**30**	**31**	**385.4**
Mar	2	14	44	52.3	-17	52	41	381.6
Mar	3	15	38	45.1	-22	28	52	377.8
Mar	4	16	36	58.1	-25	57	14	374.0
Mar	5	17	39	08.3	-27	55	29	370.4
Mar	6	18	43	46.1	-28	05	53	367.2
Mar	7	19	48	32.9	-26	21	22	364.8
Mar	8	20	51	14.1	-22	49	01	363.4
Mar	9	21	50	28.6	-17	48	17	363.4
Mar	10	22	46	02.9	-11	45	36	364.8
Mar	11	23	38	32.7	-05	08	54	367.6
Mar	12	00	28	58.0	+01	35	50	371.7
Mar	13	01	18	24.5	+08	06	04	376.8
Mar	14	02	07	52.5	+14	03	09	382.4
Mar	15	02	58	09.8	+19	11	44	388.0
Mar	16	03	49	44.8	+23	19	27	393.3
Mar	17	04	42	41.3	+26	16	39	397.9
Mar	18	05	36	35.5	+27	56	46	401.4
Mar	19	06	30	40.8	+28	16	53	403.8
Mar	20	07	24	01.6	+27	18	13	404.8
Mar	21	08	15	50.1	+25	05	46	404.6
Mar	22	09	05	39.4	+21	47	27	403.3
Mar	23	09	53	27.7	+17	32	54	401.1
Mar	24	10	39	35.8	+12	32	41	398.1
Mar	25	11	24	40.9	+06	58	01	394.6
Mar	26	12	09	31.5	+01	00	51	391.0
Mar	27	12	55	03.9	-05	05	32	387.3
Mar	28	13	42	18.8	-11	06	02	383.8
Mar	29	14	32	17.2	-16	43	05	380.6
Mar	30	15	25	50.7	-21	36	31	377.7
Mar	31	16	23	25.1	-25	24	11	375.1
April	**1**	**17**	**24**	**38.5**	**-27**	**44**	**27**	**372.9**
Apr	2	18	28	08.4	-28	20	34	371.1
Apr	3	19	31	47.9	-27	05	45	369.6
Apr	4	20	33	32.1	-24	05	38	368.7
Apr	5	21	32	03.5	-19	36	25	368.5
Apr	6	22	27	06.1	-14	00	22	369.0
Apr	7	23	19	11.5	-07	41	35	370.4
Apr	8	00	09	16.5	-01	03	34	372.8
Apr	9	00	58	25.8	+05	31	51	376.1
Apr	10	01	47	41.0	+11	44	47	380.2
Apr	11	02	37	52.6	+17	17	27	384.8
Apr	12	03	29	32.9	+21	54	20	389.5
Apr	13	04	22	48.7	+25	22	45	394.1
Apr	14	05	17	16.5	+27	33	35	398.1
Apr	15	06	12	06.4	+28	22	21	401.3
Apr	16	07	06	15.8	+27	49	37	403.5
Apr	17	07	58	49.6	+26	00	26	404.3
Apr	18	08	49	15.2	+23	02	60	403.9
Apr	19	09	37	28.3	+19	07	01	402.2
Apr	20	10	23	49.4	+14	22	35	399.4
Apr	21	11	08	57.2	+08	59	51	395.7
Apr	22	11	53	42.3	+03	09	20	391.4
Apr	23	12	39	03.6	-02	57	08	386.8
Apr	24	13	26	04.9	-09	05	26	382.3
Apr	25	14	15	51.5	-14	58	09	378.2
Apr	26	15	09	20.9	-20	14	01	374.7
Apr	27	16	07	05.4	-24	28	41	372.0
Apr	28	17	08	47.3	-27	17	35	370.2
Apr	29	18	13	01.8	-28	21	14	369.2
Apr	30	19	17	30.6	-27	31	17	369.0
May	**1**	**20**	**19**	**54.2**	**-24**	**53**	**24**	**369.4**
May	2	21	18	44.6	-20	44	36	370.4

GEOCENTRIC POSITION OF MOON (continued)

MONTH	DAY	RA			DECLINATION			DISTANCE (1,000 km)
		h	m	s	°	′	″	
May	3	22	13	42.5	-15	27	31	371.8
May	4	23	05	21.4	-09	25	28	373.7
May	5	23	54	42.3	-03	00	07	376.0
May	6	00	42	54.8	+03	28	52	378.7
May	7	01	31	06.2	+09	43	25	381.8
May	8	02	20	14.2	+15	26	26	385.3
May	9	03	11	00.1	+20	21	48	389.1
May	10	04	03	40.5	+24	14	54	392.9
May	11	04	57	59.8	+26	53	52	396.6
May	12	05	53	09.6	+28	11	18	399.8
May	13	06	48	00.7	+28	05	28	402.4
May	14	07	41	25.0	+26	40	21	404.1
May	15	08	32	36.4	+24	04	12	404.6
May	16	09	21	20.3	+20	27	24	404.0
May	17	10	07	52.0	+16	00	37	402.0
May	18	10	52	48.5	+10	53	59	398.9
May	19	11	37	01.1	+05	17	08	394.7
May	20	12	21	30.9	-00	39	57	389.7
May	21	13	07	25.6	-06	45	35	384.3
May	22	13	55	57.2	-12	44	56	378.9
May	23	14	48	15.6	-18	18	29	373.9
May	24	15	45	12.8	-23	01	40	369.6
May	25	16	46	55.1	-26	26	46	366.5
May	26	17	52	13.9	-28	08	19	364.7
May	27	18	58	43.9	-27	51	26	364.2
May	28	20	03	33.7	-25	37	49	365.0
May	29	21	04	38.2	-21	44	32	366.9
May	30	22	01	14.7	-16	37	01	369.5
May	31	22	53	49.4	-10	41	35	372.7
June	**1**	**23**	**43**	**25.8**	**-04**	**21**	**35**	**376.2**
Jun	2	00	31	19.6	+02	03	20	379.8
Jun	3	01	18	45.3	+08	16	16	383.4
Jun	4	02	06	48.6	+14	01	52	387.0
Jun	5	02	56	20.9	+19	05	28	390.5
Jun	6	03	47	51.5	+23	12	58	393.9
Jun	7	04	41	18.9	+26	11	43	397.0
Jun	8	05	36	05.9	+27	52	12	399.9
Jun	9	06	31	06.3	+28	10	03	402.4
Jun	10	07	25	04.5	+27	06	58	404.2
Jun	11	08	16	59.7	+24	50	08	405.3
Jun	12	09	06	22.3	+21	30	00	405.5
Jun	13	09	53	15.6	+17	18	09	404.6
Jun	14	10	38	09.5	+12	25	35	402.5
Jun	15	11	21	51.4	+07	02	19	399.2
Jun	16	12	05	20.1	+01	17	46	394.9
Jun	17	12	49	42.6	-04	38	13	389.6
Jun	18	13	36	12.7	-10	33	44	383.8
Jun	19	14	26	07.4	-16	13	07	377.7
Jun	20	15	20	37.3	-21	15	19	371.8
Jun	21	16	20	23.2	-25	13	42	366.7
Jun	22	17	25	01.0	-27	39	13	362.8
Jun	23	18	32	34.7	-28	08	19	360.4
Jun	24	19	40	00.5	-26	32	38	359.7
Jun	25	20	44	25.1	-23	03	15	360.7
Jun	26	21	44	15.0	-18	05	41	363.2
Jun	27	22	39	26.3	-12	10	21	366.9
Jun	28	23	30	52.6	-05	45	26	371.4
Jun	29	00	19	50.8	+00	45	55	376.3
Jun	30	01	07	40.4	+07	05	13	381.3
July	**1**	**01**	**55**	**33.7**	**+12**	**57**	**13**	**386.0**
Jul	2	02	44	29.9	+18	08	23	390.4
Jul	3	03	35	08.6	+22	26	02	394.3
Jul	4	04	27	41.8	+25	38	23	397.7
Jul	5	05	21	47.1	+27	35	47	400.6
Jul	6	06	16	29.8	+28	12	26	402.9
Jul	7	07	10	37.1	+27	28	01	404.7
Jul	8	08	03	01.8	+25	27	53	405.9
Jul	9	08	53	01.6	+22	21	39	406.4
Jul	10	09	40	27.1	+18	21	02	406.1
Jul	11	10	25	37.4	+13	37	56	404.9
Jul	12	11	09	12.3	+08	23	23	402.8
Jul	13	11	52	04.3	+02	47	27	399.6
Jul	14	12	35	15.3	-03	00	11	395.4
Jul	15	13	19	54.4	-08	49	05	390.3
Jul	16	14	07	16.3	-14	26	32	384.6
Jul	17	14	58	36.4	-19	35	48	378.4
Jul	18	15	54	56.6	-23	54	48	372.2
Jul	19	16	56	36.4	-26	56	43	366.5
Jul	20	18	02	37.4	-28	14	28	361.8
Jul	21	19	10	32.6	-27	29	46	358.6
Jul	22	20	17	14.7	-24	41	45	357.2
Jul	23	21	20	18.4	-20	08	29	357.7
Jul	24	22	18	48.4	-14	19	50	360.1
Jul	25	23	13	07.7	-07	48	14	364.1
Jul	26	00	04	21.4	-01	02	30	369.2
Jul	27	00	53	47.6	+05	34	07	374.9
Jul	28	01	42	41.4	+11	43	24	380.8
Jul	29	02	32	06.3	+17	10	41	386.5
Jul	30	03	22	48.1	+21	43	30	391.7
Jul	31	04	15	07.2	+25	11	01	396.2
August	**1**	**05**	**08**	**52.8**	**+27**	**24**	**19**	**399.9**
Aug	2	06	03	22.1	+28	17	42	402.7
Aug	3	06	57	31.0	+27	50	02	404.8
Aug	4	07	50	14.2	+26	05	21	406.0
Aug	5	08	40	45.1	+23	12	02	406.6
Aug	6	09	28	45.8	+19	21	10	406.5
Aug	7	10	14	26.7	+14	44	45	405.7
Aug	8	10	58	19.7	+09	34	34	404.2
Aug	9	11	41	10.4	+04	01	39	401.9
Aug	10	12	23	54.0	-01	43	32	398.9
Aug	11	13	07	32.3	-07	30	20	395.1
Aug	12	13	53	12.9	-13	06	56	390.6
Aug	13	14	42	05.6	-18	19	01	385.4
Aug	14	15	35	14.1	-22	48	26	379.8
Aug	15	16	33	17.1	-26	12	51	374.0
Aug	16	17	35	58.9	-28	07	39	368.5
Aug	17	18	41	47.2	-28	11	35	363.6
Aug	18	19	48	07.7	-26	14	44	359.9
Aug	19	20	52	24.6	-22	23	53	357.8
Aug	20	21	53	03.5	-17	01	01	357.5
Aug	21	22	49	48.1	-10	36	26	359.2
Aug	22	23	43	19.2	-03	41	44	362.6
Aug	23	00	34	43.6	+03	14	43	367.5
Aug	24	01	25	13.3	+09	49	25	373.3
Aug	25	02	15	52.3	+15	43	36	379.5
Aug	26	03	07	28.4	+20	42	18	385.7
Aug	27	04	00	25.7	+24	33	40	391.4
Aug	28	04	54	38.3	+27	08	47	396.4
Aug	29	05	49	29.5	+28	22	18	400.4
Aug	30	06	44	01.3	+28	13	15	403.3
Aug	31	07	37	11.8	+26	45	25	405.2
September	**1**	**08**	**28**	**15.1**	**+24**	**06**	**33**	**406.1**

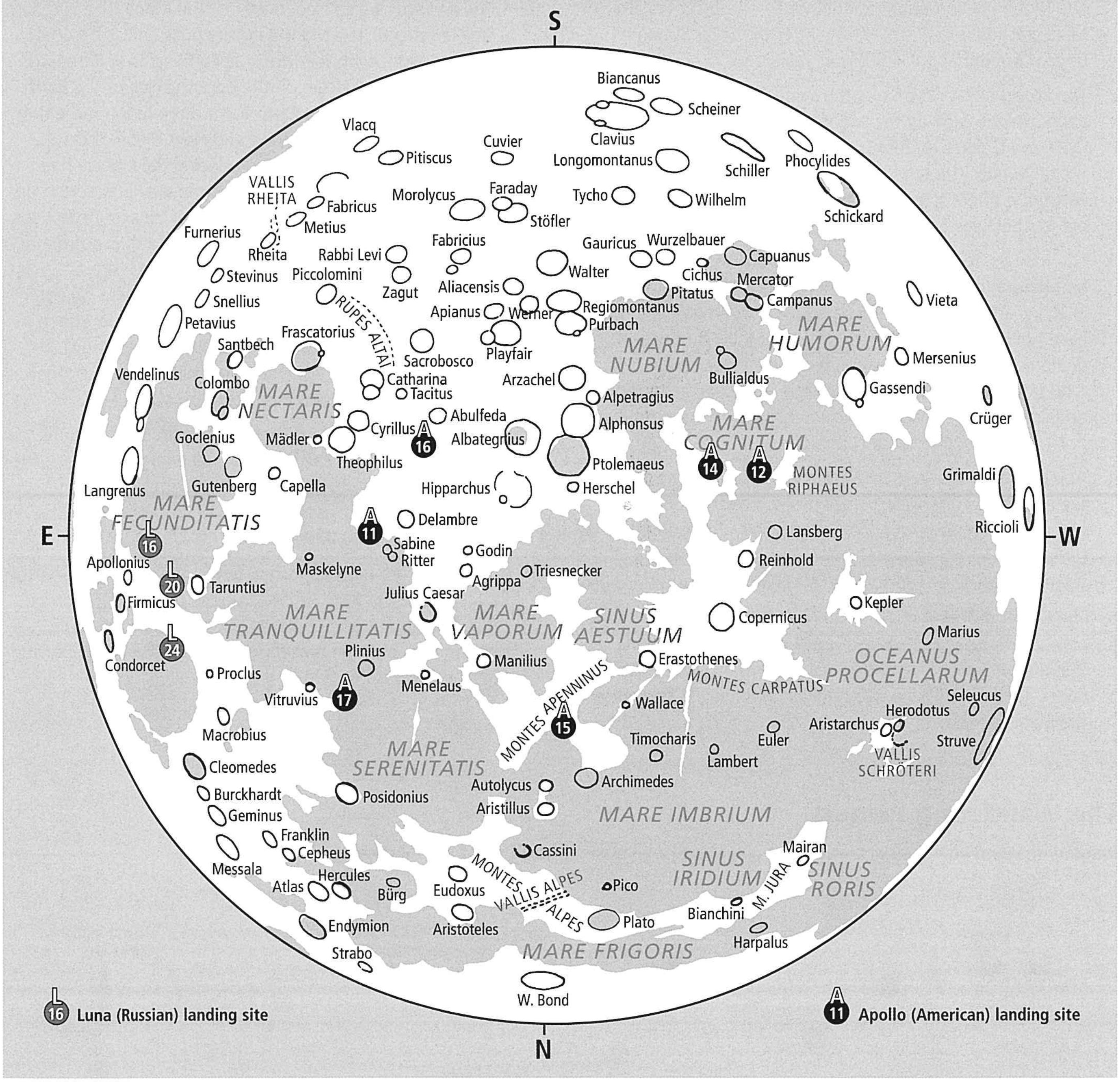
GEOCENTRIC POSITION OF MOON

Note: positions refer to 0000 WAST

MONTH	DAY	RA			DECLINATION			DISTANCE (1,000 km)
		h	m	s	°	′	″	
Sep	2	09	16	51.2	+20	27	04	406.1
Sep	3	10	03	07.1	+15	58	29	405.3
Sep	4	10	47	30.5	+10	52	28	403.9
Sep	5	11	30	43.0	+05	20	24	401.9
Sep	6	12	13	35.3	-00	26	32	399.5
Sep	7	12	57	03.6	-06	16	55	396.5
Sep	8	13	42	08.8	-11	58	24	393.1
Sep	9	14	29	53.3	-17	16	50	389.2
Sep	10	15	21	14.5	-21	55	31	385.0
Sep	11	16	16	51.0	-25	34	51	380.4
Sep	12	17	16	41.3	-27	53	30	375.7
Sep	13	18	19	43.9	-28	32	04	371.1
Sep	14	19	24	00.8	-27	18	38	366.9
Sep	15	20	27	17.0	-24	13	37	363.5
Sep	16	21	27	53.0	-19	30	39	361.2
Sep	17	22	25	12.9	-13	32	60	360.4
Sep	18	23	19	37.3	-06	48	37	361.3
Sep	19	00	12	00.3	+00	13	59	363.9
Sep	20	01	03	27.6	+07	08	17	367.9
Sep	21	01	55	02.2	+13	31	01	373.1
Sep	22	02	47	33.1	+19	02	38	378.9
Sep	23	03	41	26.7	+23	27	29	384.9
Sep	24	04	36	38.3	+26	34	04	390.7
Sep	25	05	32	30.8	+28	15	44	395.8
Sep	26	06	28	03.4	+28	31	10	399.9
Sep	27	07	22	11.3	+27	24	21	402.9
Sep	28	08	14	05.5	+25	03	25	404.7
Sep	29	09	03	25.1	+21	38	53	405.3
Sep	30	09	50	17.0	+17	22	04	404.8
October	**1**	**10**	**35**	**09.6**	**+12**	**24**	**13**	**403.4**
Oct	2	11	18	45.0	+06	56	12	401.2
Oct	3	12	01	53.9	+01	08	56	398.6
Oct	4	12	45	31.8	-04	46	05	395.5
Oct	5	13	30	37.6	-10	35	59	392.3
Oct	6	14	18	10.7	-16	05	58	388.9
Oct	7	15	09	04.5	-20	58	41	385.5
Oct	8	16	03	53.9	-24	54	29	382.2
Oct	9	17	02	36.6	-27	32	49	378.8
Oct	10	18	04	16.4	-28	35	33	375.6
Oct	11	19	07	07.1	-27	51	37	372.5
Oct	12	20	09	05.4	-25	20	41	369.8
Oct	13	21	08	38.4	-21	13	29	367.5
Oct	14	22	05	09.1	-15	48	46	366.0
Oct	15	22	58	53.8	-09	29	33	365.5
Oct	16	23	50	42.4	-02	40	15	366.1
Oct	17	00	41	39.4	+04	14	48	368.0
Oct	18	01	32	50.0	+10	52	03	371.1
Oct	19	02	25	08.8	+16	49	35	375.3
Oct	20	03	19	09.4	+21	47	47	380.2
Oct	21	04	14	53.5	+25	30	45	385.5
Oct	22	05	11	45.2	+27	47	48	390.7
Oct	23	06	08	37.1	+28	34	52	395.5
Oct	24	07	04	11.5	+27	54	46	399.5
Oct	25	07	57	26.2	+25	55	52	402.4
Oct	26	08	47	50.9	+22	49	37	404.1
Oct	27	09	35	28.7	+18	48	10	404.4
Oct	28	10	20	48.7	+14	03	04	403.6
Oct	29	11	04	35.9	+08	44	48	401.6
Oct	30	11	47	44.2	+03	03	22	398.7
Oct	31	12	31	12.8	-02	50	50	395.1
November	**1**	**13**	**16**	**04.2**	**-08**	**45**	**55**	**391.2**

MONTH	DAY	RA			DECLINATION			DISTANCE (1,000 km)
		h	m	s	°	′	″	
Nov	2	14	03	21.7	-14	27	26	387.2
Nov	3	14	54	03.4	-19	37	36	383.4
Nov	4	15	48	49.5	-23	55	25	380.0
Nov	5	16	47	41.5	-26	58	18	377.0
Nov	6	17	49	42.9	-28	25	59	374.6
Nov	7	18	52	59.7	-28	06	07	372.8
Nov	8	19	55	17.5	-25	58	14	371.4
Nov	9	20	54	52.7	-22	13	45	370.5
Nov	10	21	51	03.5	-17	11	44	370.1
Nov	11	22	44	06.1	-11	14	17	370.1
Nov	12	23	34	53.0	-04	43	30	370.7
Nov	13	00	24	32.9	+01	59	26	372.0
Nov	14	01	14	16.8	+08	34	02	373.9
Nov	15	02	05	08.3	+14	40	10	376.6
Nov	16	02	57	54.0	+19	58	09	380.0
Nov	17	03	52	51.3	+24	09	50	383.9
Nov	18	04	49	37.9	+27	00	30	388.2
Nov	19	05	47	10.1	+28	21	28	392.5
Nov	20	06	44	00.1	+28	11	50	396.6
Nov	21	07	38	45.5	+26	38	11	400.0
Nov	22	08	30	35.3	+23	52	08	402.6
Nov	23	09	19	18.5	+20	07	06	404.1
Nov	24	10	05	17.2	+15	36	01	404.3
Nov	25	10	49	15.4	+10	30	08	403.2
Nov	26	11	32	08.6	+04	59	19	400.8
Nov	27	12	14	59.2	-00	47	11	397.3
Nov	28	12	58	53.8	-06	39	21	393.0
Nov	29	13	45	02.1	-12	24	59	388.1
Nov	30	14	34	32.9	-17	48	14	383.1
December	**1**	**15**	**28**	**22.7**	**-22**	**28**	**41**	**378.3**
Dec	2	16	26	54.9	-26	02	04	374.2
Dec	3	17	29	31.7	-28	03	50	370.9
Dec	4	18	34	21.0	-28	15	47	368.7
Dec	5	19	38	45.5	-26	32	58	367.6
Dec	6	20	40	26.9	-23	5	38	367.5
Dec	7	21	38	15.3	-18	14	54	368.3
Dec	8	22	32	13.4	-12	25	52	369.8
Dec	9	23	23	12.4	-06	02	41	371.8
Dec	10	00	12	24.5	+00	33	11	374.1
Dec	11	01	01	06.7	+07	02	44	376.7
Dec	12	01	50	30.7	+13	08	17	379.5
Dec	13	02	41	34.4	+18	32	40	382.5
Dec	14	03	34	52.3	+22	59	02	385.8
Dec	15	04	30	22.9	+26	12	04	389.1
Dec	16	05	27	21.4	+28	00	19	392.5
Dec	17	06	24	26.6	+28	18	50	395.9
Dec	18	07	20	06.8	+27	10	30	399.1
Dec	19	08	13	10.6	+24	44	59	401.7
Dec	20	09	03	05.6	+21	15	45	403.7
Dec	21	09	49	58.3	+16	56	54	404.8
Dec	22	10	34	23.3	+12	01	18	404.8
Dec	23	11	17	11.8	+06	39	56	403.6
Dec	24	11	59	24.0	+01	02	15	401.2
Dec	25	12	42	05.8	-04	42	40	397.5
Dec	26	13	26	28.1	-10	24	51	392.8
Dec	27	14	13	44.3	-15	51	38	387.3
Dec	28	15	05	05.1	-20	46	12	381.5
Dec	29	16	01	21.7	-24	46	34	375.7
Dec	30	17	02	38.0	-27	27	00	370.4
Dec	31	18	07	40.4	-28	23	11	366.1

MAP OF THE MOON



MOON PHASES

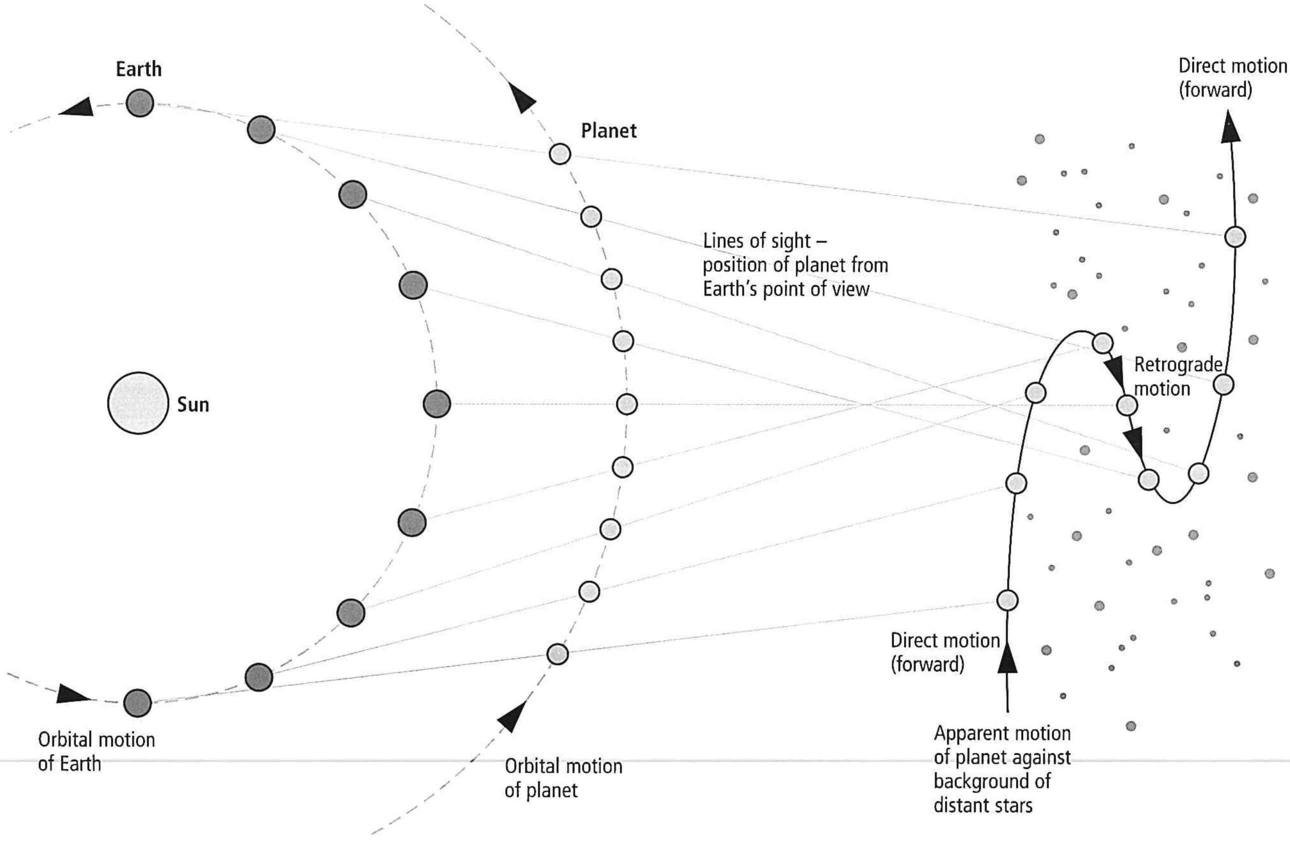
	● NEW MOON			◑ FIRST QUARTER			○ FULL MOON			◐ LAST QUARTER		
Lunation	**Month**	**d**	**h m**	**Month**	**d**	**h m**	**Month**	**d**	**h m**	**Month**	**d**	**h m**
1014										January	4	0146
1015	January	10	2003	January	17	1457	January	25	1832	February	2	1527
1016	February	9	0628	February	16	0816	February	24	1254	March	4	0136
1017	March	10	1710	March	18	0319	March	26	0458	April	2	0850
1018	April	9	0432	April	16	2237	April	24	1806	May	1	1424
1019	May	8	1645	May	16	1657	May	24	0418	May	30	1947
1020	June	7	0555	June	15	0922	June	22	1214	June	29	0223
1021	July	6	2002	July	14	2320	July	21	1900	July	28	1119
1022	August	5	1105	August	13	1038	August	20	0153	August	26	2318
1023	September	4	0245	September	11	1937	September	18	1001	September	25	1441
1024	October	3	1828	October	11	0301	October	17	2014	October	25	0917
1025	November	2	0925	November	9	0957	November	16	0857	November	24	0611
1026	December	1	2301	December	8	1736	December	16	0015	December	24	0336
1027	December	31	1112									

Moon Facts

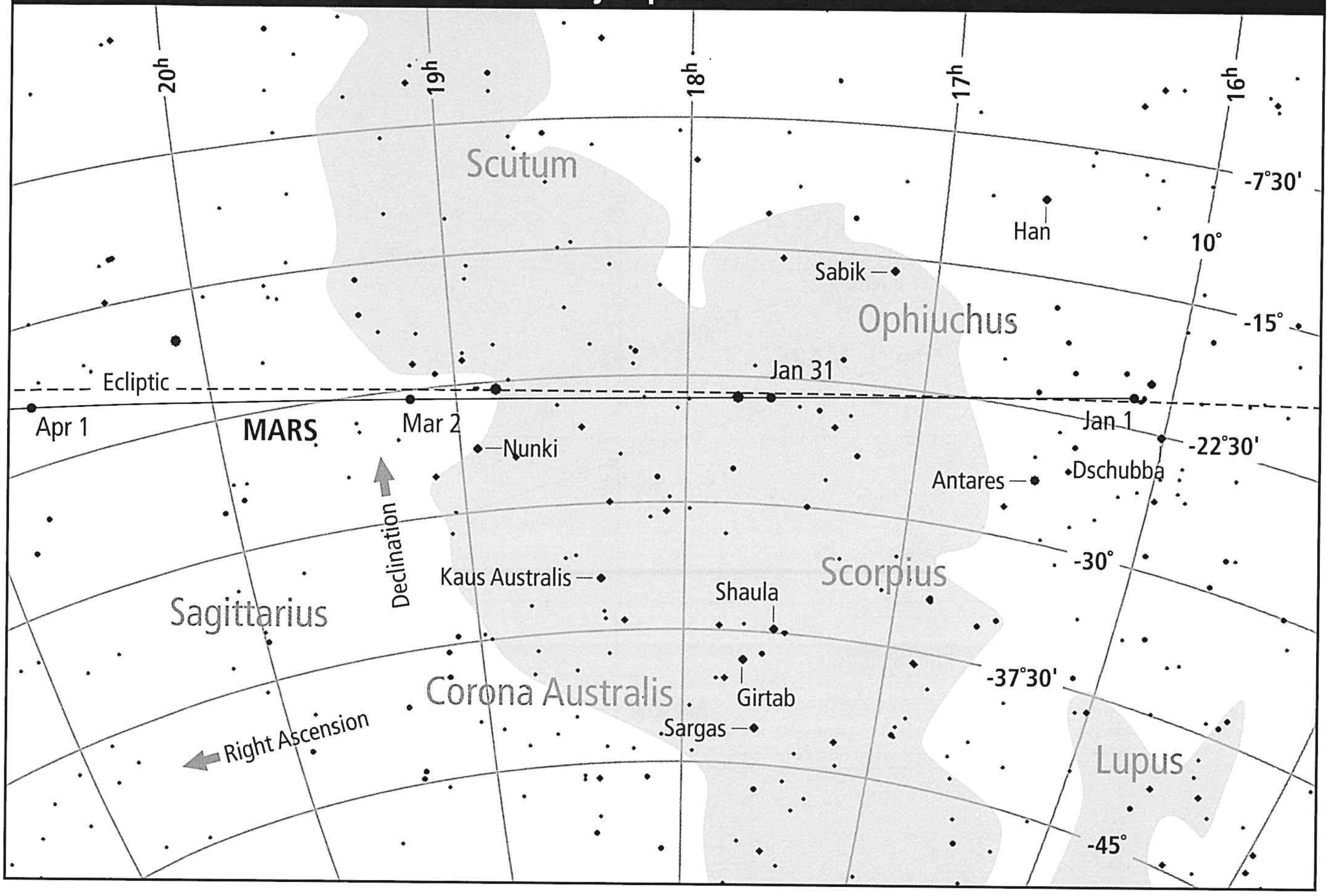
1. The Moon was probably created when an object the size of Mars crashed into Earth, shortly after the Solar System began forming about 4.5 billion years ago.
2. The Moon always shows us the same face. Long ago, the Earth's gravity slowed the Moon's rotation about its axis. Once the Moon's rotation slowed enough to match its orbital period (the time it takes the Moon to go around Earth) the effect steadied. Many of the moons around other planets behave similarly.
3. The Moon's heavily cratered surface is the result of intense bombardment by space rocks between 4.1 billion and 3.8 billion years ago. The craters are scars from this event. They have not changed much because, the Moon is not very geologically active, so earthquakes, volcanoes and mountain-building don't destroy the landscape as they do on Earth, and with virtually no atmosphere there is no wind or rain, so very little erosion occurs.
4. Apollo astronauts used seismometers during their visits to the Moon and discovered small moonquakes originating several kilometres below the surface. They are thought to be caused by the gravitational pull of Earth. Sometimes tiny fractures appear at the surface, and gas escapes.
5. The Moon probably has a small core that is hot and perhaps partially molten, as is Earth's core. It's between 2 and 4 percent of its mass which is tiny compared with Earth, in which the iron core makes up about 30 percent of the planet's mass.
6. Tides on Earth are caused mostly by the Moon (the Sun has a smaller effect). The Moon's gravity pulls on Earth's oceans. High tide aligns with the Moon as Earth spins underneath. Another high tide occurs on the opposite side of the Earth because gravity pulls the Earth toward the Moon more than it pulls the water. At Full Moon and New Moon, the Sun, Earth and Moon are lined up, producing the higher than normal tides (called spring tides, for the way they spring up). When the Moon is at first or last quarter, smaller neap tides form. The Moon's 29.5-day orbit around Earth is not quite circular. When the Moon is closest to Earth (called its perigee), spring tides are even higher, and they're called perigean spring tides. This has another interesting effect: Some of Earth's rotational energy is lost to the Moon, causing our planet to slow down so that the day lengthens by about 1.5 milliseconds every century.
7. The Moon is moving away from the Earth. Each year, the Moon takes some of Earth's rotational energy, and uses it to propel itself about 38 mm higher in its orbit. When it formed, the Moon was about 22,530 km from Earth, but it's now more than 380,000 km away.
8. The Moon's orbit lies approximately in the same plane as the Earth's about the Sun. At Last Quarter phase the Moon's orbital position is at its furthest ahead of the Earth. The location of the Moon is also within about 5° of the direction that the Earth is heading at that time.

The Wandering Planets

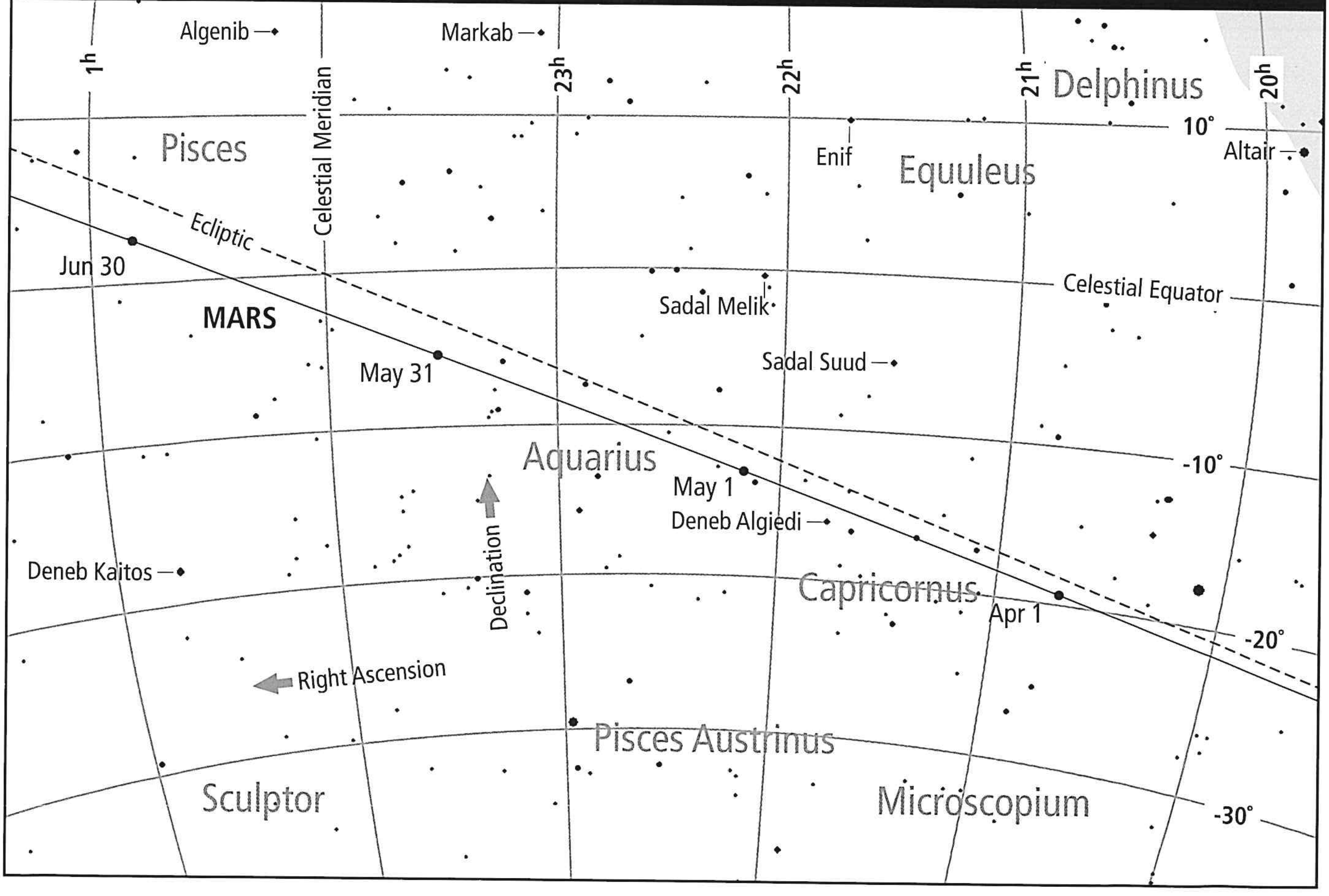
Diagram showing how the sky motion of a planet arises because of its different orbital speed to that of the Earth.



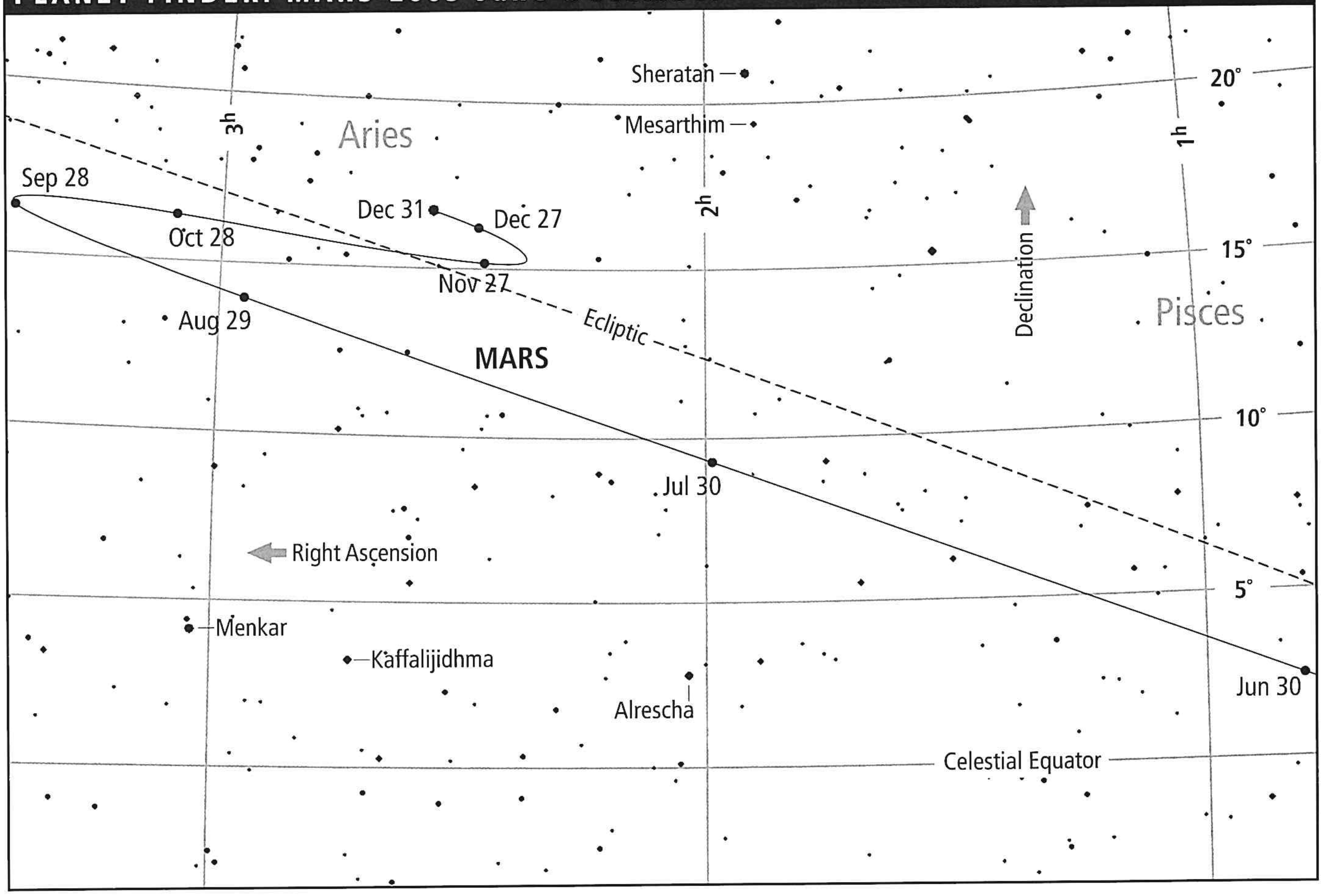
PLANET FINDER: MARS 2005 January-April



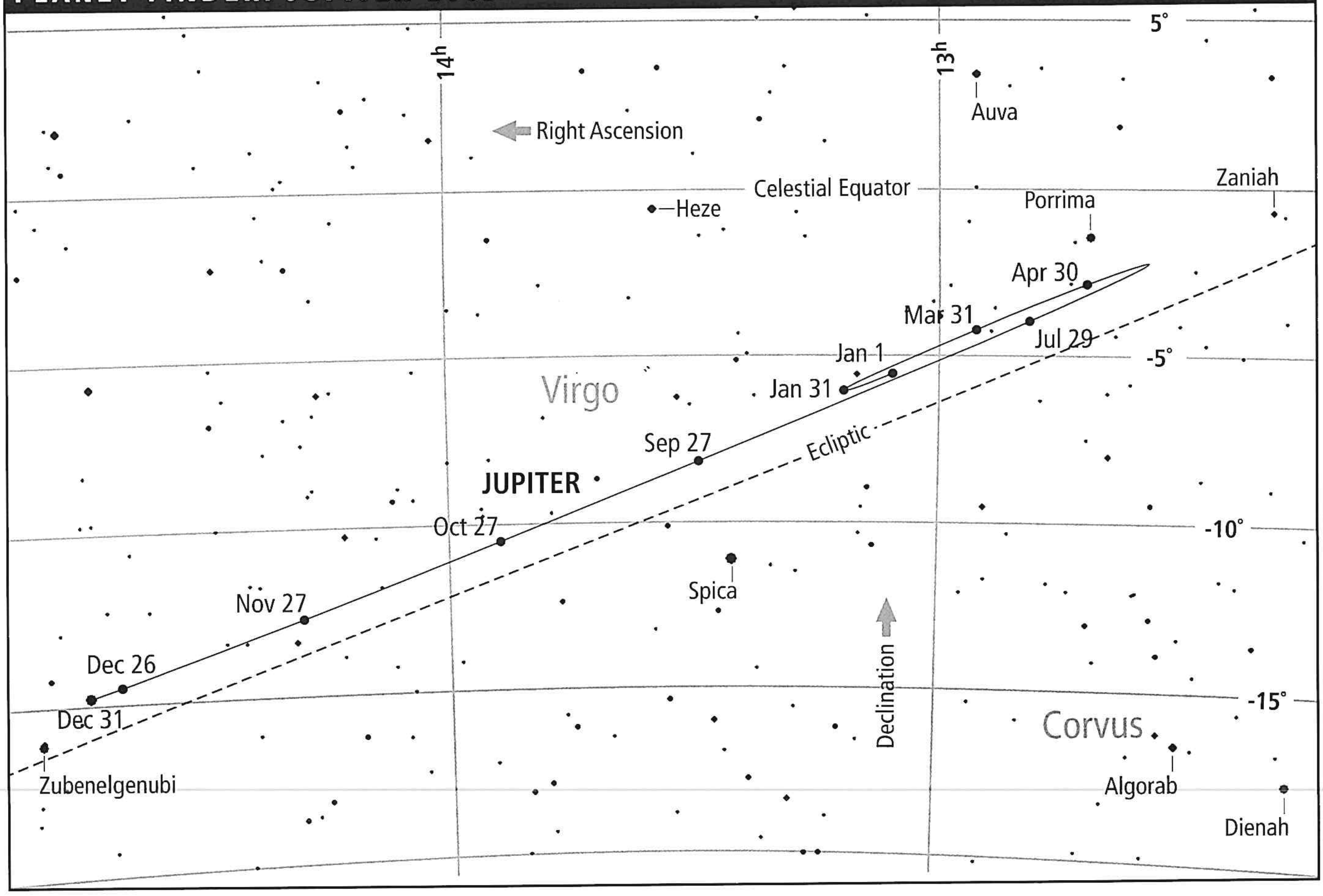
PLANET FINDER: MARS 2005 April-June



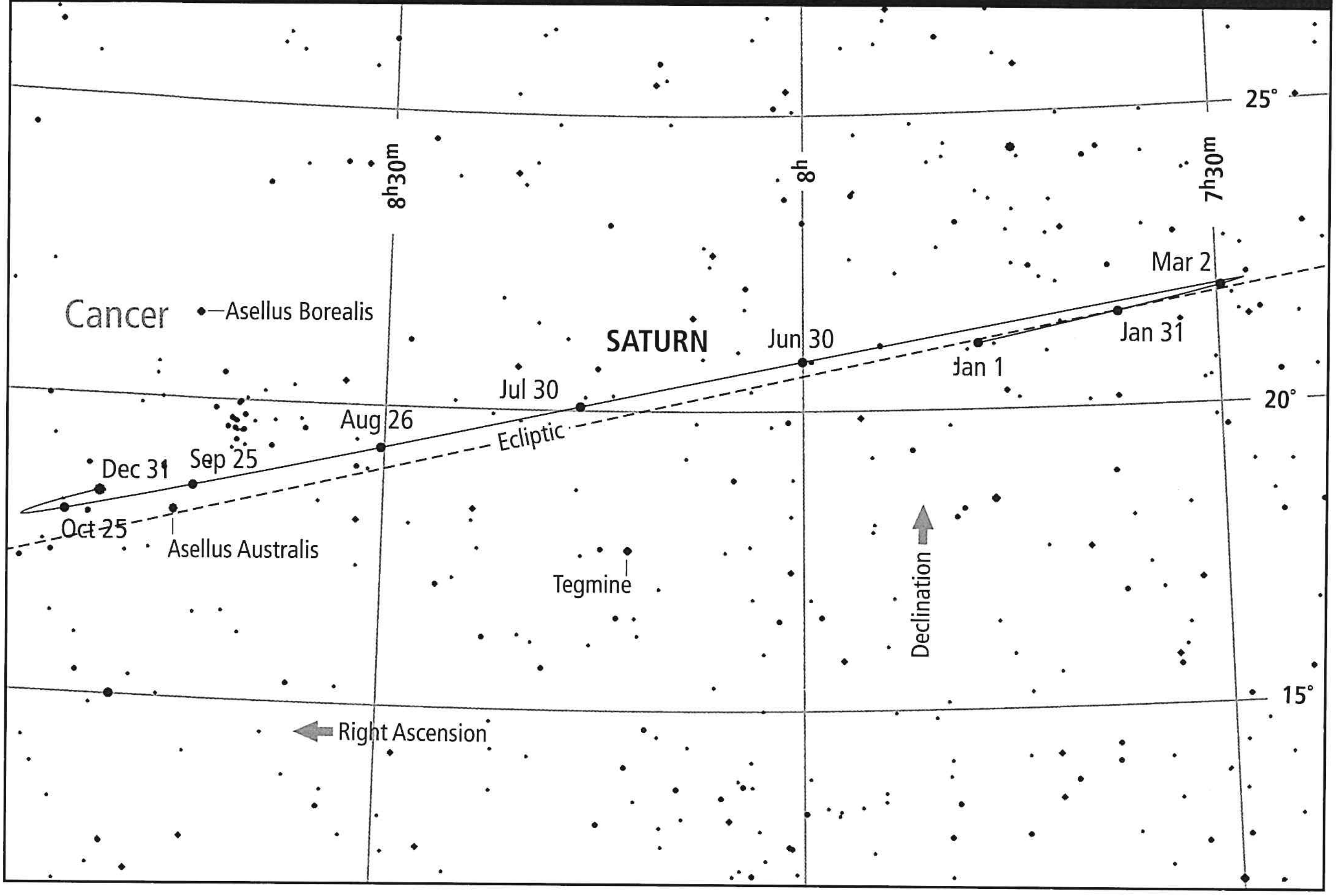
PLANET FINDER: MARS 2005 June-December



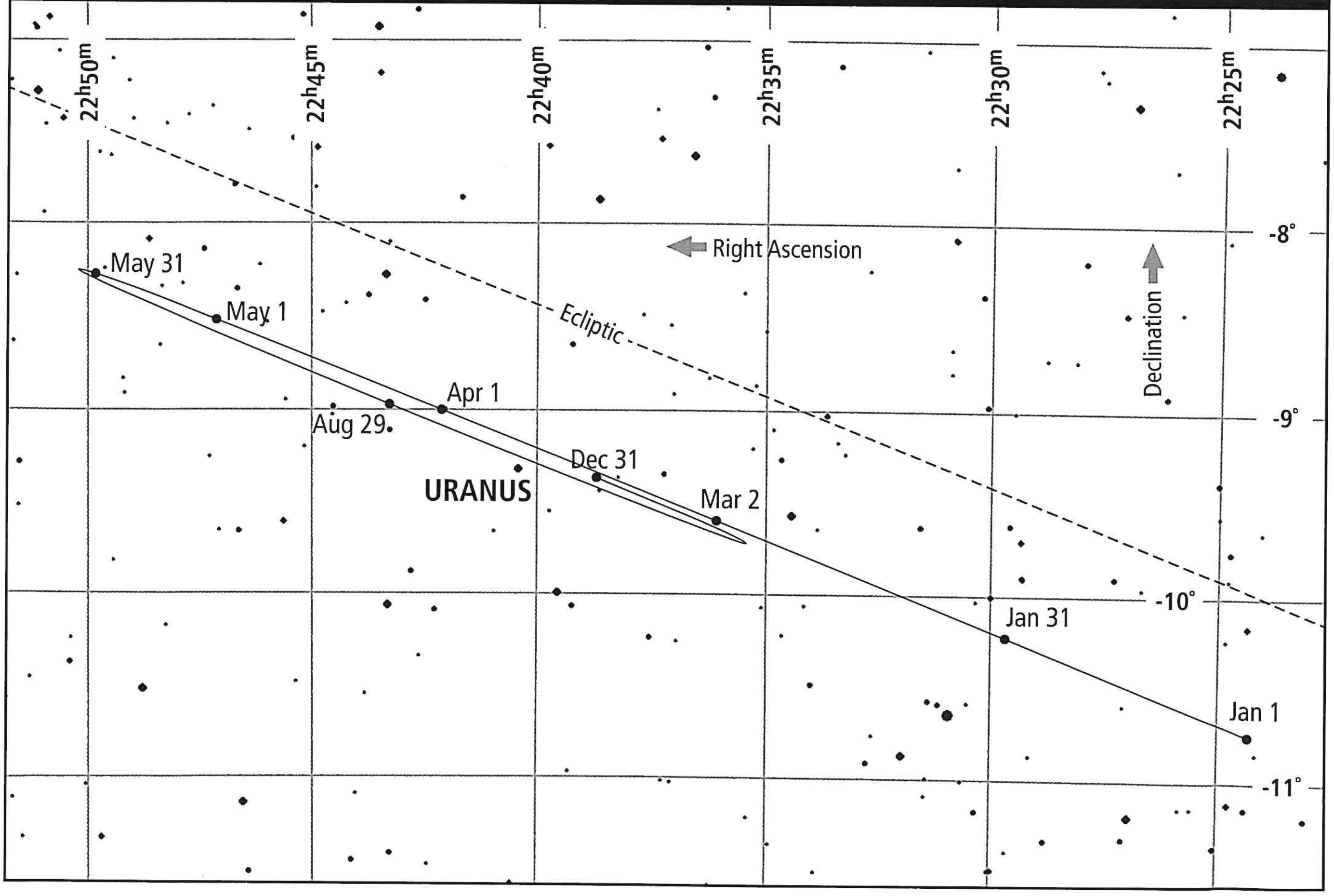
PLANET FINDER: JUPITER 2005



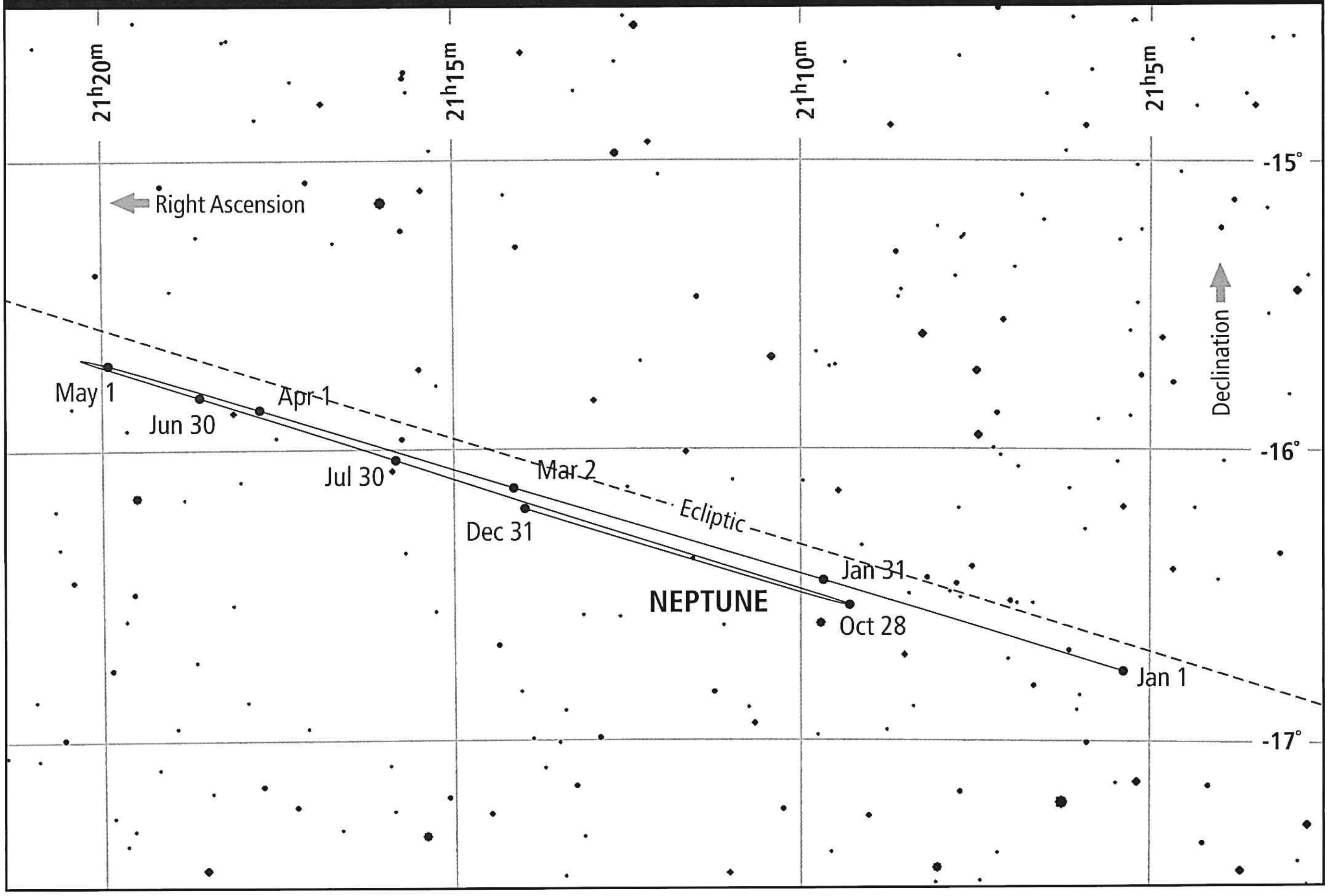
PLANET FINDER: SATURN 2005



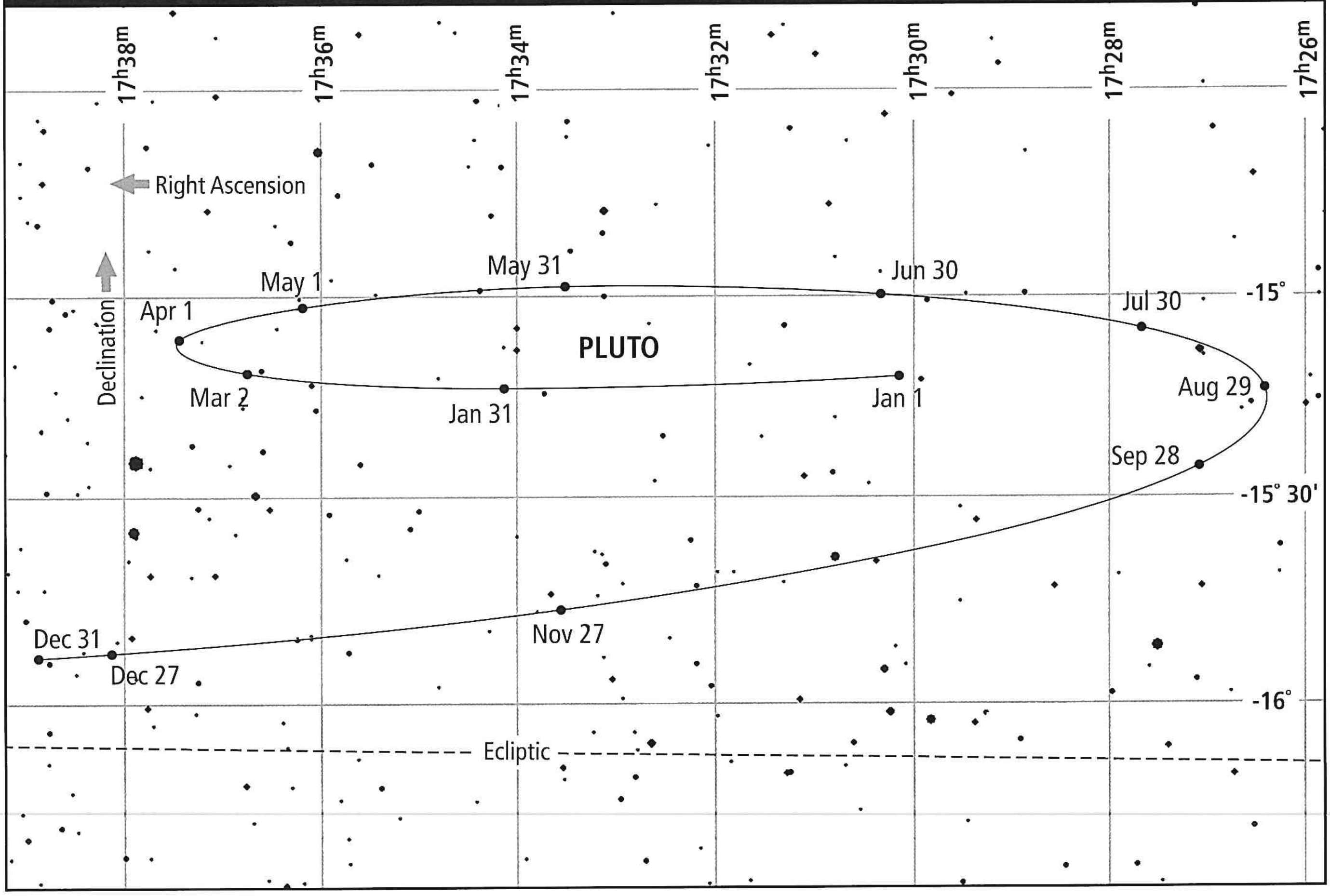
PLANET FINDER: URANUS 2005



PLANET FINDER: NEPTUNE 2005



PLANET FINDER: PLUTO 2005



GEOCENTRIC PLANET POSITIONS (EPOCH J2000.0) Note: positions refer to 0000 WAST

		MERCURY			VENUS			MARS			JUPITER		
MTH	DAY	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Jan	1	17 08 03.4	-21 11 16	1.051	17 10 27.1	-22 11 32	1.540	16 08 12.5	-20 47 27	2.252	13 05 20.7	-05 33 11	5.485
Jan	2	17 12 48.0	-21 25 34	1.071	17 15 49.7	-22 20 03	1.544	16 11 05.9	-20 55 41	2.245	13 05 42.2	-05 35 08	5.469
Jan	3	17 17 44.0	-21 39 34	1.089	17 21 12.9	-22 27 55	1.548	16 13 59.7	-21 03 45	2.239	13 06 03.1	-05 37 01	5.453
Jan	4	17 22 50.6	-21 53 08	1.108	17 26 36.8	-22 35 06	1.551	16 16 53.9	-21 11 39	2.232	13 06 23.3	-05 38 51	5.437
Jan	5	17 28 06.6	-22 06 11	1.125	17 32 01.3	-22 41 37	1.555	16 19 48.6	-21 19 22	2.226	13 06 43.0	-05 40 36	5.421
Jan	6	17 33 31.2	-22 18 38	1.142	17 37 26.3	-22 47 26	1.558	16 22 43.7	-21 26 54	2.219	13 07 02.1	-05 42 18	5.405
Jan	7	17 39 03.6	-22 30 22	1.159	17 42 51.8	-22 52 34	1.562	16 25 39.2	-21 34 15	2.213	13 07 20.6	-05 43 56	5.389
Jan	8	17 44 43.2	-22 41 20	1.175	17 48 17.7	-22 57 01	1.566	16 28 35.1	-21 41 25	2.206	13 07 38.5	-05 45 30	5.373
Jan	9	17 50 29.2	-22 51 27	1.190	17 53 44.0	-23 00 45	1.569	16 31 31.5	-21 48 24	2.199	13 07 55.8	-05 47 00	5.356
Jan	10	17 56 21.1	-23 00 40	1.205	17 59 10.6	-23 03 48	1.573	16 34 28.2	-21 55 11	2.192	13 08 12.4	-05 48 26	5.340
Jan	11	18 02 18.4	-23 08 56	1.219	18 04 37.4	-23 06 08	1.576	16 37 25.4	-22 01 48	2.186	13 08 28.4	-05 49 48	5.324
Jan	12	18 08 20.8	-23 16 12	1.233	18 10 04.4	-23 07 46	1.579	16 40 22.9	-22 08 12	2.179	13 08 43.7	-05 51 06	5.308
Jan	13	18 14 27.7	-23 22 26	1.246	18 15 31.5	-23 08 41	1.583	16 43 20.9	-22 14 26	2.172	13 08 58.5	-05 52 20	5.292
Jan	14	18 20 38.8	-23 27 34	1.258	18 20 58.7	-23 08 53	1.586	16 46 19.1	-22 20 27	2.165	13 09 12.5	-05 53 30	5.276
Jan	15	18 26 53.8	-23 31 36	1.270	18 26 25.8	-23 08 23	1.589	16 49 17.8	-22 26 17	2.158	13 09 25.9	-05 54 36	5.260
Jan	16	18 33 12.4	-23 34 29	1.281	18 31 52.9	-23 07 10	1.593	16 52 16.8	-22 31 55	2.151	13 09 38.7	-05 55 38	5.244
Jan	17	18 39 34.2	-23 36 12	1.292	18 37 19.8	-23 05 15	1.596	16 55 16.2	-22 37 21	2.145	13 09 50.8	-05 56 35	5.228
Jan	18	18 45 59.1	-23 36 43	1.303	18 42 46.6	-23 02 37	1.599	16 58 15.9	-22 42 35	2.138	13 10 02.2	-05 57 29	5.212
Jan	19	18 52 26.8	-23 35 60	1.313	18 48 13.1	-22 59 16	1.602	17 01 15.9	-22 47 37	2.131	13 10 13.0	-05 58 18	5.196
Jan	20	18 58 57.1	-23 34 02	1.322	18 53 39.3	-22 55 14	1.605	17 04 16.3	-22 52 26	2.124	13 10 23.1	-05 59 03	5.180
Jan	21	19 05 29.8	-23 30 49	1.331	18 59 05.2	-22 50 28	1.608	17 07 17.0	-22 57 04	2.117	13 10 32.5	-05 59 44	5.164
Jan	22	19 12 04.7	-23 26 18	1.339	19 04 30.6	-22 45 01	1.611	17 10 18.0	-23 01 29	2.110	13 10 41.2	-06 00 21	5.148
Jan	23	19 18 41.7	-23 20 30	1.347	19 09 55.6	-22 38 52	1.614	17 13 19.4	-23 05 41	2.103	13 10 49.3	-06 00 53	5.133
Jan	24	19 25 20.5	-23 13 22	1.354	19 15 20.0	-22 32 02	1.617	17 16 21.0	-23 09 42	2.095	13 10 56.7	-06 01 21	5.117
Jan	25	19 32 01.1	-23 04 55	1.361	19 20 43.8	-22 24 30	1.620	17 19 23.0	-23 13 29	2.088	13 11 03.4	-06 01 45	5.101
Jan	26	19 38 43.3	-22 55 06	1.368	19 26 07.1	-22 16 18	1.623	17 22 25.2	-23 17 04	2.081	13 11 09.3	-06 02 05	5.086
Jan	27	19 45 27.0	-22 43 57	1.374	19 31 29.6	-22 07 24	1.626	17 25 27.7	-23 20 26	2.074	13 11 14.6	-06 02 21	5.071
Jan	28	19 52 12.0	-22 31 25	1.379	19 36 51.5	-21 57 50	1.628	17 28 30.5	-23 23 36	2.067	13 11 19.2	-06 02 32	5.055
Jan	29	19 58 58.2	-22 17 30	1.384	19 42 12.6	-21 47 37	1.631	17 31 33.6	-23 26 32	2.060	13 11 23.1	-06 02 39	5.040
Jan	30	20 05 45.7	-22 02 11	1.388	19 47 32.9	-21 36 43	1.634	17 34 36.9	-23 29 16	2.053	13 11 26.3	-06 02 42	5.025
Jan	31	20 12 34.1	-21 45 29	1.392	19 52 52.3	-21 25 11	1.637	17 37 40.5	-23 31 47	2.045	13 11 28.8	-06 02 40	5.010
Feb	1	20 19 23.6	-21 27 22	1.396	19 58 10.9	-21 13 00	1.639	17 40 44.3	-23 34 04	2.038	13 11 30.6	-06 02 35	4.995
Feb	2	20 26 13.9	-21 07 49	1.399	20 03 28.5	-21 00 11	1.642	17 43 48.4	-23 36 09	2.031	13 11 31.7	-06 02 24	4.980
Feb	3	20 33 05.0	-20 46 52	1.401	20 08 45.2	-20 46 44	1.644	17 46 52.7	-23 38 01	2.024	13 11 32.0	-06 02 10	4.965
Feb	4	20 39 56.9	-20 24 28	1.403	20 14 00.9	-20 32 41	1.647	17 49 57.1	-23 39 39	2.016	13 11 31.7	-06 01 51	4.951
Feb	5	20 46 49.5	-20 00 38	1.405	20 19 15.6	-20 17 60	1.649	17 53 01.8	-23 41 04	2.009	13 11 30.6	-06 01 28	4.936
Feb	6	20 53 42.7	-19 35 21	1.406	20 24 29.3	-20 02 44	1.652	17 56 06.7	-23 42 16	2.002	13 11 28.8	-06 01 01	4.922
Feb	7	21 00 36.5	-19 08 38	1.406	20 29 41.9	-19 46 52	1.654	17 59 11.7	-23 43 14	1.995	13 11 26.3	-06 00 29	4.908
Feb	8	21 07 30.8	-18 40 28	1.406	20 34 53.4	-19 30 25	1.657	18 02 16.9	-23 43 59	1.987	13 11 23.1	-05 59 53	4.894
Feb	9	21 14 25.6	-18 10 50	1.405	20 40 03.7	-19 13 24	1.659	18 05 22.2	-23 44 31	1.980	13 11 19.2	-05 59 13	4.880
Feb	10	21 21 20.8	-17 39 46	1.403	20 45 13.0	-18 55 49	1.661	18 08 27.7	-23 44 50	1.972	13 11 14.6	-05 58 28	4.866
Feb	11	21 28 16.3	-17 07 14	1.401	20 50 21.1	-18 37 42	1.664	18 11 33.3	-23 44 54	1.965	13 11 09.2	-05 57 40	4.852
Feb	12	21 35 12.3	-16 33 16	1.399	20 55 28.0	-18 19 02	1.666	18 14 38.9	-23 44 46	1.958	13 11 03.2	-05 56 47	4.839
Feb	13	21 42 08.4	-15 57 51	1.395	21 00 33.7	-17 59 51	1.668	18 17 44.7	-23 44 24	1.950	13 10 56.4	-05 55 50	4.825
Feb	14	21 49 04.9	-15 21 00	1.391	21 05 38.3	-17 40 09	1.670	18 20 50.5	-23 43 49	1.943	13 10 49.0	-05 54 48	4.812
Feb	15	21 56 01.4	-14 42 44	1.386	21 10 41.6	-17 19 57	1.672	18 23 56.5	-23 42 60	1.936	13 10 40.8	-05 53 43	4.799
Feb	16	22 02 58.0	-14 03 04	1.380	21 15 43.8	-16 59 16	1.674	18 27 02.4	-23 41 58	1.928	13 10 32.0	-05 52 34	4.786
Feb	17	22 09 54.6	-13 21 60	1.374	21 20 44.7	-16 38 06	1.676	18 30 08.5	-23 40 42	1.921	13 10 22.5	-05 51 20	4.774
Feb	18	22 16 51.1	-12 39 34	1.367	21 25 44.5	-16 16 28	1.678	18 33 14.5	-23 39 13	1.913	13 10 12.3	-05 50 03	4.761
Feb	19	22 23 47.2	-11 55 48	1.358	21 30 43.1	-15 54 22	1.680	18 36 20.6	-23 37 30	1.906	13 10 01.5	-05 48 41	4.749
Feb	20	22 30 42.8	-11 10 44	1.349	21 35 40.5	-15 31 51	1.682	18 39 26.7	-23 35 34	1.898	13 09 50.0	-05 47 16	4.737
Feb	21	22 37 37.7	-10 24 26	1.339	21 40 36.8	-15 08 53	1.684	18 42 32.9	-23 33 24	1.891	13 09 37.8	-05 45 47	4.725
Feb	22	22 44 31.6	-09 36 56	1.328	21 45 31.9	-14 45 30	1.686	18 45 39.0	-23 31 01	1.884	13 09 25.0	-05 44 14	4.714
Feb	23	22 51 24.2	-08 48 18	1.316	21 50 25.9	-14 21 43	1.688	18 48 45.2	-23 28 25	1.876	13 09 11.5	-05 42 37	4.702
Feb	24	22 58 14.9	-07 58 38	1.303	21 55 18.7	-13 57 33	1.689	18 51 51.3	-23 25 35	1.869	13 08 57.4	-05 40 56	4.691
Feb	25	23 05 03.4	-07 08 01	1.288	22 00 10.4	-13 32 59	1.691	18 54 57.4	-23 22 32	1.861	13 08 42.6	-05 39 12	4.680
Feb	26	23 11 49.1	-06 16 34	1.273	22 05 01.1	-13 08 04	1.693	18 58 03.4	-23 19 16	1.854	13 08 27.3	-05 37 24	4.669
Feb	27	23 18 31.1	-05 24 25	1.256	22 09 50.7	-12 42 47	1.694	19 01 09.5	-23 15 46	1.846	13 08 11.3	-05 35 33	4.659
Feb	28	23 25 08.7	-04 31 44	1.238	22 14 39.3	-12 17 09	1.696	19 04 15.4	-23 12 03	1.839	13 07 54.7	-05 33 38	4.648
Mar	1	23 31 41.0	-03 38 41	1.219	22 19 26.8	-11 51 12	1.697	19 07 21.3	-23 08 07	1.831	13 07 37.6	-05 31 40	4.638
Mar	2	23 38 06.8	-02 45 27	1.199	22 24 13.4	-11 24 55	1.699	19 10 27.2	-23 03 57	1.824	13 07 19.8	-05 29 38	4.628
Mar	3	23 44 24.9	-01 52 17	1.177	22 28 59.0	-10 58 20	1.700	19 13 32.9	-22 59 35	1.817	13 07 01.5	-05 27 33	4.619
Mar	4	23 50 34.0	-00 59 24	1.155	22 33 43.7	-10 31 28	1.702	19 16 38.6	-22 54 59	1.809	13 06 42.6	-05 25 24	4.609
Mar	5	23 56 32.6	-00 07 05	1.131	22 38 27.5	-10 04 18	1.703	19 19 44.1	-22 50 10	1.802	13 06 23.1	-05 23 13	4.600
Mar	6	00 02 19.0	+00 44 23	1.106	22 43 10.4	-09 36 52	1.705	19 22 49.6	-22 45 08	1.794	13 06 03.1	-05 20 58	4.591
Mar	7	00 07 51.7	+01 34 42	1.081	22 47 52.4	-09 09 11	1.706	19 25 54.9	-22 39 53	1.787	13 05 42.6	-05 18 40	4.583
Mar	8	00 13 08.7	+02 23 35	1.054	22 52 33.7	-08 41 16	1.707	19 29 00.0	-22 34 26	1.779	13 05 21.6	-05 16 20	4.574

GEOCENTRIC PLANET POSITIONS (continued)

Note: positions refer to 0000 WAST

MTH	DAY	MERCURY			VENUS			MARS			JUPITER		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Mar	9	00 18 08.3	+03 10 41	1.027	22 57 14.2	-08 13 06	1.708	19 32 05.0	-22 28 45	1.772	13 05 00.0	-05 13 56	4.566
Mar	10	00 22 48.7	+03 55 43	1.000	23 01 53.9	-07 44 43	1.710	19 35 09.9	-22 22 52	1.764	13 04 38.0	-05 11 30	4.559
Mar	11	00 27 08.1	+04 38 21	0.972	23 06 32.9	-07 16 08	1.711	19 38 14.5	-22 16 46	1.757	13 04 15.5	-05 09 01	4.551
Mar	12	00 31 04.8	+05 18 17	0.945	23 11 11.2	-06 47 21	1.712	19 41 19.0	-22 10 28	1.749	13 03 52.5	-05 06 29	4.544
Mar	13	00 34 37.3	+05 55 14	0.917	23 15 48.9	-06 18 23	1.713	19 44 23.3	-22 03 57	1.742	13 03 29.1	-05 03 55	4.537
Mar	14	00 37 44.1	+06 28 56	0.889	23 20 26.0	-05 49 16	1.714	19 47 27.3	-21 57 13	1.735	13 03 05.3	-05 01 19	4.530
Mar	15	00 40 23.9	+06 59 07	0.862	23 25 02.5	-05 19 58	1.715	19 50 31.1	-21 50 18	1.727	13 02 41.1	-04 58 40	4.524
Mar	16	00 42 35.9	+07 25 34	0.836	23 29 38.4	-04 50 33	1.716	19 53 34.7	-21 43 10	1.720	13 02 16.4	-04 55 59	4.517
Mar	17	00 44 19.2	+07 48 03	0.810	23 34 13.9	-04 20 59	1.717	19 56 38.1	-21 35 50	1.712	13 01 51.4	-04 53 16	4.512
Mar	18	00 45 33.4	+08 06 26	0.786	23 38 48.9	-03 51 19	1.717	19 59 41.3	-21 28 18	1.705	13 01 26.1	-04 50 32	4.506
Mar	19	00 46 18.3	+08 20 32	0.762	23 43 23.5	-03 21 32	1.718	20 02 44.2	-21 20 34	1.697	13 01 00.4	-04 47 45	4.501
Mar	20	00 46 34.3	+08 30 16	0.740	23 47 57.7	-02 51 39	1.719	20 05 46.8	-21 12 38	1.690	13 00 34.4	-04 44 57	4.496
Mar	21	00 46 21.9	+08 35 32	0.718	23 52 31.5	-02 21 41	1.720	20 08 49.2	-21 04 30	1.683	13 00 08.1	-04 42 07	4.491
Mar	22	00 45 42.3	+08 36 21	0.699	23 57 05.1	-01 51 39	1.720	20 11 51.3	-20 56 11	1.675	12 59 41.5	-04 39 16	4.487
Mar	23	00 44 37.0	+08 32 43	0.681	00 01 38.4	-01 21 34	1.721	20 14 53.2	-20 47 40	1.668	12 59 14.6	-04 36 23	4.482
Mar	24	00 43 07.9	+08 24 45	0.664	00 06 11.5	-00 51 26	1.721	20 17 54.8	-20 38 58	1.661	12 58 47.5	-04 33 30	4.479
Mar	25	00 41 17.4	+08 12 36	0.649	00 10 44.4	-00 21 16	1.722	20 20 56.2	-20 30 04	1.653	12 58 20.2	-04 30 35	4.475
Mar	26	00 39 08.4	+07 56 31	0.636	00 15 17.3	+00 08 56	1.722	20 23 57.2	-20 20 59	1.646	12 57 52.7	-04 27 39	4.472
Mar	27	00 36 44.1	+07 36 48	0.624	00 19 50.0	+00 39 08	1.723	20 26 58.0	-20 11 43	1.639	12 57 25.0	-04 24 42	4.469
Mar	28	00 34 07.7	+07 13 50	0.615	00 24 22.7	+01 09 20	1.723	20 29 58.5	-20 02 16	1.631	12 56 57.1	-04 21 44	4.466
Mar	29	00 31 23.0	+06 48 03	0.607	00 28 55.4	+01 39 32	1.724	20 32 58.7	-19 52 38	1.624	12 56 29.0	-04 18 46	4.464
Mar	30	00 28 33.7	+06 19 56	0.600	00 33 28.1	+02 09 42	1.724	20 35 58.7	-19 42 50	1.617	12 56 00.8	-04 15 48	4.462
Mar	31	00 25 43.4	+05 50 02	0.596	00 38 01.0	+02 39 49	1.724	20 38 58.3	-19 32 50	1.609	12 55 32.5	-04 12 48	4.460
Apr	1	00 22 55.8	+05 18 54	0.593	00 42 34.0	+03 09 54	1.724	20 41 57.6	-19 22 40	1.602	12 55 04.2	-04 09 49	4.459
Apr	2	00 20 14.1	+04 47 05	0.591	00 47 07.1	+03 39 55	1.724	20 44 56.7	-19 12 20	1.595	12 54 35.7	-04 06 50	4.458
Apr	3	00 17 41.3	+04 15 08	0.591	00 51 40.5	+04 09 52	1.725	20 47 55.4	-19 01 49	1.588	12 54 07.2	-04 03 50	4.457
Apr	4	00 15 20.1	+03 43 34	0.592	00 56 14.2	+04 39 44	1.725	20 50 53.8	-18 51 08	1.580	12 53 38.6	-04 00 50	4.457
Apr	5	00 13 12.8	+03 12 50	0.595	01 00 48.2	+05 09 30	1.725	20 53 51.8	-18 40 17	1.573	12 53 10.0	-03 57 51	4.457
Apr	6	00 11 21.1	+02 43 21	0.599	01 05 22.5	+05 39 10	1.725	20 56 49.5	-18 29 16	1.566	12 52 41.5	-03 54 52	4.457
Apr	7	00 09 46.6	+02 15 29	0.604	01 09 57.1	+06 08 42	1.724	20 59 46.9	-18 18 06	1.559	12 52 12.9	-03 51 54	4.457
Apr	8	00 08 30.2	+01 49 32	0.610	01 14 32.3	+06 38 07	1.724	21 02 44.0	-18 06 45	1.552	12 51 44.4	-03 48 56	4.458
Apr	9	00 07 32.7	+01 25 44	0.618	01 19 07.8	+07 07 22	1.724	21 05 40.7	-17 55 16	1.544	12 51 16.0	-03 45 59	4.459
Apr	10	00 06 54.3	+01 04 16	0.626	01 23 43.9	+07 36 28	1.724	21 08 37.0	-17 43 37	1.537	12 50 47.7	-03 43 03	4.461
Apr	11	00 06 35.3	+00 45 15	0.635	01 28 20.5	+08 05 24	1.724	21 11 33.0	-17 31 50	1.530	12 50 19.4	-03 40 08	4.462
Apr	12	00 06 35.4	+00 28 48	0.644	01 32 57.6	+08 34 09	1.723	21 14 28.6	-17 19 53	1.523	12 49 51.4	-03 37 14	4.464
Apr	13	00 06 54.3	+00 14 57	0.655	01 37 35.4	+09 02 42	1.723	21 17 23.9	-17 07 47	1.516	12 49 23.4	-03 34 21	4.467
Apr	14	00 07 31.6	+00 03 42	0.666	01 42 13.8	+09 31 03	1.722	21 20 18.7	-16 55 33	1.509	12 48 55.6	-03 31 30	4.469
Apr	15	00 08 26.7	-00 04 56	0.677	01 46 52.9	+09 59 10	1.722	21 23 13.3	-16 43 11	1.502	12 48 28.1	-03 28 40	4.472
Apr	16	00 09 39.0	-00 10 59	0.689	01 51 32.6	+10 27 04	1.721	21 26 07.4	-16 30 40	1.494	12 48 00.7	-03 25 52	4.475
Apr	17	00 11 07.8	-00 14 30	0.701	01 56 13.2	+10 54 43	1.721	21 29 01.2	-16 18 01	1.487	12 47 33.6	-03 23 06	4.479
Apr	18	00 12 52.4	-00 15 33	0.714	02 00 54.4	+11 22 06	1.720	21 31 54.7	-16 05 14	1.480	12 47 06.7	-03 20 22	4.483
Apr	19	00 14 52.1	-00 14 12	0.727	02 05 36.5	+11 49 13	1.719	21 34 47.8	-15 52 19	1.473	12 46 40.0	-03 17 39	4.487
Apr	20	00 17 06.1	-00 10 31	0.741	02 10 19.4	+12 16 03	1.718	21 37 40.5	-15 39 16	1.466	12 46 13.7	-03 14 59	4.491
Apr	21	00 19 33.9	-00 04 34	0.755	02 15 03.2	+12 42 36	1.718	21 40 32.9	-15 26 06	1.459	12 45 47.6	-03 12 21	4.496
Apr	22	00 22 14.7	+00 03 33	0.769	02 19 47.9	+13 08 50	1.717	21 43 24.9	-15 12 48	1.452	12 45 21.9	-03 09 45	4.501
Apr	23	00 25 07.9	+00 13 46	0.783	02 24 33.4	+13 34 44	1.716	21 46 16.6	-14 59 23	1.445	12 44 56.5	-03 07 12	4.506
Apr	24	00 28 13.0	+00 25 60	0.798	02 29 20.0	+14 00 19	1.715	21 49 07.9	-14 45 51	1.438	12 44 31.4	-03 04 41	4.512
Apr	25	00 31 29.3	+00 40 10	0.812	02 34 07.4	+14 25 34	1.714	21 51 58.8	-14 32 11	1.432	12 44 06.7	-03 02 12	4.517
Apr	26	00 34 56.4	+00 56 12	0.827	02 38 55.9	+14 50 27	1.713	21 54 49.5	-14 18 25	1.425	12 43 42.4	-02 59 47	4.523
Apr	27	00 38 33.9	+01 14 02	0.842	02 43 45.4	+15 14 58	1.712	21 57 39.7	-14 04 32	1.418	12 43 18.5	-02 57 24	4.530
Apr	28	00 42 21.2	+01 33 34	0.858	02 48 36.0	+15 39 06	1.710	22 00 29.7	-13 50 33	1.411	12 42 55.0	-02 55 04	4.536
Apr	29	00 46 18.1	+01 54 45	0.873	02 53 27.6	+16 02 50	1.709	22 03 19.3	-13 36 27	1.404	12 42 31.9	-02 52 47	4.543
Apr	30	00 50 24.2	+02 17 31	0.888	02 58 20.2	+16 26 11	1.708	22 06 08.5	-13 22 15	1.397	12 42 09.2	-02 50 33	4.550
May	1	00 54 39.2	+02 41 48	0.904	03 03 14.0	+16 49 06	1.706	22 08 57.4	-13 07 57	1.390	12 41 46.9	-02 48 22	4.558
May	2	00 59 02.8	+03 07 32	0.920	03 08 08.9	+17 11 35	1.705	22 11 46.0	-12 53 33	1.384	12 41 25.2	-02 46 14	4.565
May	3	01 03 35.0	+03 34 39	0.935	03 13 04.9	+17 33 39	1.704	22 14 34.2	-12 39 03	1.377	12 41 03.9	-02 44 10	4.573
May	4	01 08 15.4	+04 03 05	0.951	03 18 02.0	+17 55 14	1.702	22 17 22.0	-12 24 28	1.370	12 40 43.1	-02 42 08	4.582
May	5	01 13 04.0	+04 32 47	0.967	03 23 00.2	+18 16 22	1.700	22 20 09.5	-12 09 48	1.363	12 40 22.7	-02 40 11	4.590
May	6	01 18 00.7	+05 03 42	0.983	03 27 59.5	+18 37 02	1.699	22 22 56.7	-11 55 03	1.356	12 40 02.9	-02 38 17	4.599
May	7	01 23 05.5	+05 35 45	0.999	03 33 00.0	+18 57 11	1.697	22 25 43.5	-11 40 12	1.350	12 39 43.6	-02 36 26	4.607
May	8	01 28 18.2	+06 08 54	1.015	03 38 01.6	+19 16 51	1.695	22 28 29.9	-11 25 17	1.343	12 39 24.9	-02 34 39	4.617
May	9	01 33 39.0	+06 43 06	1.031	03 43 04.4	+19 35 60	1.694	22 31 16.0	-11 10 17	1.336	12 39 06.7	-02 32 56	4.626
May	10	01 39 07.8	+07 18 16	1.047	03 48 08.2	+19 54 37	1.692	22 34 01.7	-10 55 14	1.330	12 38 49.1	-02 31 16	4.636
May	11	01 44 44.8	+07 54 21	1.063	03 53 13.1	+20 12 43	1.690	22 36 47.0	-10 40 05	1.323	12 38 32.0	-02 29 40	4.645
May	12	01 50 30.1	+08 31 18	1.079	03 58 19.1	+20 30 15	1.688	22 39 32.0	-10 24 53	1.316	12 38 15.5	-02 28 09	4.655
May	13	01 56 23.8	+09 09 03	1.094	04 03 26.2	+20 47 14	1.686	22 42 16.7	-10 09 37	1.310	12 37 59.5	-02 26 41	4.666
May	14	02 02 26.1	+09 47 32	1.110	04 08 34.3	+21 03 38	1.684	22 45 01.0	-09 54 18	1.303	12 37 44.2	-02 25 17	4.676

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	MERCURY			VENUS			MARS			JUPITER		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
May	15	02 08 37.2	+10 26 42	1.126	04 13 43.5	+21 19 28	1.681	22 47 44.9	-09 38 55	1.297	12 37 29.5	-02 23 57	4.687
May	16	02 14 57.2	+11 06 28	1.141	04 18 53.6	+21 34 43	1.679	22 50 28.5	-09 23 28	1.290	12 37 15.4	-02 22 41	4.698
May	17	02 21 26.6	+11 46 45	1.156	04 24 04.8	+21 49 21	1.677	22 53 11.8	-09 07 59	1.284	12 37 01.9	-02 21 30	4.709
May	18	02 28 05.4	+12 27 28	1.171	04 29 16.9	+22 03 23	1.675	22 55 54.7	-08 52 26	1.277	12 36 49.0	-02 20 22	4.720
May	19	02 34 54.0	+13 08 34	1.186	04 34 29.9	+22 16 47	1.672	22 58 37.3	-08 36 51	1.270	12 36 36.7	-02 19 19	4.732
May	20	02 41 52.6	+13 49 55	1.200	04 39 43.8	+22 29 34	1.670	23 01 19.6	-08 21 13	1.264	12 36 25.1	-02 18 20	4.743
May	21	02 49 01.4	+14 31 25	1.214	04 44 58.6	+22 41 43	1.667	23 04 01.6	-08 05 33	1.258	12 36 14.1	-02 17 25	4.755
May	22	02 56 20.8	+15 12 58	1.227	04 50 14.1	+22 53 13	1.665	23 06 43.2	-07 49 50	1.251	12 36 03.7	-02 16 34	4.767
May	23	03 03 50.8	+15 54 26	1.240	04 55 30.5	+23 04 04	1.662	23 09 24.5	-07 34 04	1.245	12 35 54.0	-02 15 47	4.779
May	24	03 11 31.8	+16 35 42	1.252	05 00 47.6	+23 14 15	1.659	23 12 05.5	-07 18 17	1.238	12 35 44.9	-02 15 05	4.792
May	25	03 19 23.7	+17 16 36	1.264	05 06 05.4	+23 23 47	1.657	23 14 46.2	-07 02 28	1.232	12 35 36.4	-02 14 27	4.804
May	26	03 27 26.6	+17 56 59	1.275	05 11 23.8	+23 32 37	1.654	23 17 26.6	-06 46 37	1.226	12 35 28.7	-02 13 53	4.817
May	27	03 35 40.4	+18 36 41	1.284	05 16 42.9	+23 40 48	1.651	23 20 06.7	-06 30 45	1.219	12 35 21.5	-02 13 23	4.830
May	28	03 44 05.0	+19 15 31	1.293	05 22 02.5	+23 48 16	1.648	23 22 46.5	-06 14 51	1.213	12 35 15.0	-02 12 58	4.843
May	29	03 52 40.1	+19 53 16	1.301	05 27 22.7	+23 55 04	1.645	23 25 26.0	-05 58 56	1.206	12 35 09.2	-02 12 37	4.856
May	30	04 01 25.2	+20 29 47	1.308	05 32 43.3	+24 01 09	1.642	23 28 05.1	-05 42 60	1.200	12 35 04.0	-02 12 20	4.869
May	31	04 10 19.7	+21 04 49	1.313	05 38 04.3	+24 06 33	1.639	23 30 44.0	-05 27 03	1.194	12 34 59.5	-02 12 08	4.882
Jun	1	04 19 22.9	+21 38 11	1.317	05 43 25.6	+24 11 14	1.636	23 33 22.6	-05 11 05	1.188	12 34 55.6	-02 11 60	4.896
Jun	2	04 28 33.7	+22 09 41	1.320	05 48 47.3	+24 15 13	1.633	23 36 00.8	-04 55 07	1.181	12 34 52.4	-02 11 56	4.909
Jun	3	04 37 51.0	+22 39 07	1.322	05 54 09.2	+24 18 29	1.630	23 38 38.7	-04 39 09	1.175	12 34 49.9	-02 11 57	4.923
Jun	4	04 47 13.7	+23 06 19	1.322	05 59 31.3	+24 21 02	1.626	23 41 16.3	-04 23 11	1.169	12 34 48.0	-02 12 01	4.937
Jun	5	04 56 40.4	+23 31 07	1.320	06 04 53.5	+24 22 52	1.623	23 43 53.6	-04 07 13	1.163	12 34 46.8	-02 12 11	4.951
Jun	6	05 06 09.5	+23 53 23	1.317	06 10 15.7	+24 23 59	1.619	23 46 30.5	-03 51 16	1.156	12 34 46.3	-02 12 24	4.965
Jun	7	05 15 39.6	+24 12 60	1.313	06 15 37.9	+24 24 23	1.616	23 49 07.2	-03 35 19	1.150	12 34 46.4	-02 12 42	4.980
Jun	8	05 25 09.2	+24 29 53	1.307	06 21 00.0	+24 24 04	1.613	23 51 43.5	-03 19 22	1.144	12 34 47.2	-02 13 04	4.994
Jun	9	05 34 36.7	+24 44 00	1.300	06 26 22.0	+24 23 01	1.609	23 54 19.4	-03 03 27	1.138	12 34 48.7	-02 13 30	5.008
Jun	10	05 44 00.7	+24 55 19	1.292	06 31 43.8	+24 21 16	1.605	23 56 55.0	-02 47 33	1.132	12 34 50.8	-02 14 01	5.023
Jun	11	05 53 19.8	+25 03 51	1.282	06 37 05.3	+24 18 47	1.602	23 59 30.4	-02 31 40	1.126	12 34 53.6	-02 14 36	5.038
Jun	12	06 02 32.8	+25 09 37	1.272	06 42 26.5	+24 15 35	1.598	00 02 05.3	-02 15 49	1.120	12 34 57.0	-02 15 15	5.052
Jun	13	06 11 38.5	+25 12 41	1.260	06 47 47.3	+24 11 41	1.594	00 04 40.0	-01 59 59	1.114	12 35 01.1	-02 15 58	5.067
Jun	14	06 20 35.8	+25 13 08	1.248	06 53 07.6	+24 07 04	1.590	00 07 14.3	-01 44 11	1.107	12 35 05.9	-02 16 46	5.082
Jun	15	06 29 24.0	+25 11 03	1.235	06 58 27.4	+24 01 44	1.586	00 09 48.3	-01 28 24	1.101	12 35 11.3	-02 17 37	5.097
Jun	16	06 38 02.2	+25 06 33	1.221	07 03 46.7	+23 55 42	1.582	00 12 21.9	-01 12 40	1.095	12 35 17.3	-02 18 33	5.112
Jun	17	06 46 29.8	+24 59 44	1.207	07 09 05.3	+23 48 59	1.578	00 14 55.3	-00 56 58	1.089	12 35 24.0	-02 19 33	5.127
Jun	18	06 54 46.2	+24 50 44	1.192	07 14 23.2	+23 41 33	1.574	00 17 28.3	-00 41 18	1.083	12 35 31.4	-02 20 37	5.142
Jun	19	07 02 51.1	+24 39 40	1.176	07 19 40.3	+23 33 27	1.570	00 20 00.9	-00 25 41	1.077	12 35 39.3	-02 21 45	5.157
Jun	20	07 10 44.2	+24 26 40	1.160	07 24 56.7	+23 24 39	1.566	00 22 33.3	-00 10 07	1.071	12 35 47.9	-02 22 57	5.173
Jun	21	07 18 25.0	+24 11 52	1.144	07 30 12.2	+23 15 11	1.562	00 25 05.3	+00 05 25	1.065	12 35 57.2	-02 24 13	5.188
Jun	22	07 25 53.6	+23 55 23	1.128	07 35 26.9	+23 05 03	1.557	00 27 37.0	+00 20 54	1.059	12 36 07.0	-02 25 33	5.203
Jun	23	07 33 09.6	+23 37 21	1.111	07 40 40.6	+22 54 15	1.553	00 30 08.4	+00 36 21	1.054	12 36 17.5	-02 26 57	5.218
Jun	24	07 40 13.1	+23 17 53	1.095	07 45 53.3	+22 42 47	1.549	00 32 39.4	+00 51 43	1.048	12 36 28.6	-02 28 25	5.234
Jun	25	07 47 03.9	+22 57 07	1.078	07 51 05.1	+22 30 41	1.544	00 35 10.2	+01 07 03	1.042	12 36 40.3	-02 29 56	5.249
Jun	26	07 53 42.0	+22 35 09	1.061	07 56 15.7	+22 17 56	1.540	00 37 40.5	+01 22 19	1.036	12 36 52.6	-02 31 31	5.265
Jun	27	08 00 07.4	+22 12 07	1.044	08 01 25.4	+22 04 34	1.535	00 40 10.6	+01 37 31	1.030	12 37 05.5	-02 33 11	5.280
Jun	28	08 06 20.1	+21 48 07	1.027	08 06 33.9	+21 50 34	1.530	00 42 40.2	+01 52 40	1.024	12 37 19.0	-02 34 53	5.296
Jun	29	08 12 20.0	+21 23 15	1.010	08 11 41.2	+21 35 57	1.526	00 45 09.5	+02 07 44	1.018	12 37 33.1	-02 36 40	5.311
Jun	30	08 18 07.1	+20 57 39	0.994	08 16 47.5	+21 20 44	1.521	00 47 38.5	+02 22 44	1.012	12 37 47.8	-02 38 30	5.327
Jul	1	08 23 41.5	+20 31 25	0.977	08 21 52.5	+21 04 55	1.516	00 50 07.0	+02 37 40	1.007	12 38 03.1	-02 40 24	5.342
Jul	2	08 29 03.0	+20 04 37	0.960	08 26 56.3	+20 48 31	1.512	00 52 35.2	+02 52 31	1.001	12 38 19.0	-02 42 22	5.358
Jul	3	08 34 11.6	+19 37 23	0.944	08 31 58.9	+20 31 32	1.507	00 55 02.9	+03 07 17	0.995	12 38 35.5	-02 44 23	5.373
Jul	4	08 39 07.3	+19 09 48	0.927	08 37 00.2	+20 13 60	1.502	00 57 30.2	+03 21 59	0.989	12 38 52.5	-02 46 28	5.389
Jul	5	08 43 49.9	+18 41 59	0.911	08 42 00.3	+19 55 54	1.497	00 59 57.1	+03 36 35	0.983	12 39 10.1	-02 48 36	5.404
Jul	6	08 48 19.3	+18 14 00	0.895	08 46 59.0	+19 37 16	1.492	01 02 23.6	+03 51 06	0.978	12 39 28.3	-02 50 48	5.420
Jul	7	08 52 35.4	+17 45 59	0.879	08 51 56.5	+19 18 06	1.487	01 04 49.6	+04 05 31	0.972	12 39 47.0	-02 53 03	5.435
Jul	8	08 56 38.0	+17 17 60	0.863	08 56 52.7	+18 58 24	1.482	01 07 15.2	+04 19 51	0.966	12 40 06.3	-02 55 22	5.451
Jul	9	09 00 26.8	+16 50 09	0.847	09 01 47.5	+18 38 12	1.477	01 09 40.3	+04 34 05	0.960	12 40 26.2	-02 57 44	5.466
Jul	10	09 04 01.8	+16 22 34	0.832	09 06 41.1	+18 17 30	1.472	01 12 04.9	+04 48 14	0.954	12 40 46.6	-03 00 09	5.482
Jul	11	09 07 22.5	+15 55 18	0.817	09 11 33.3	+17 56 18	1.466	01 14 29.0	+05 02 16	0.949	12 41 07.5	-03 02 38	5.497
Jul	12	09 10 28.8	+15 28 30	0.802	09 16 24.2	+17 34 39	1.461	01 16 52.6	+05 16 12	0.943	12 41 29.0	-03 05 10	5.513
Jul	13	09 13 20.2	+15 02 14	0.787	09 21 13.7	+17 12 31	1.456	01 19 15.8	+05 30 02	0.937	12 41 51.0	-03 07 45	5.528
Jul	14	09 15 56.4	+14 36 38	0.772	09 26 02.0	+16 49 57	1.450	01 21 38.4	+05 43 46	0.932	12 42 13.5	-03 10 23	5.543
Jul	15	09 18 17.1	+14 11 48	0.758	09 30 48.9	+16 26 56	1.445	01 24 00.5	+05 57 23	0.926	12 42 36.6	-03 13 05	5.559
Jul	16	09 20 21.9	+13 47 51	0.744	09 35 34.5	+16 03 29	1.440	01 26 22.0	+06 10 54	0.920	12 43 00.1	-03 15 49	5.574
Jul	17	09 22 10.3	+13 24 54	0.731	09 40 18.8	+15 39 38	1.434	01 28 43.1	+06 24 18	0.915	12 43 24.2	-03 18 37	5.589
Jul	18	09 23 42.0	+13 03 04	0.718	09 45 01.8	+15 15 22	1.428	01 31 03.5	+06 37 36	0.909	12 43 48.7	-03 21 28	5.604
Jul	19	09 24 56.4	+12 42 28	0.705	09 49 43.6	+14 50 43	1.423	01 33 23.4	+06 50 47	0.903	12 44 13.8	-03 24 21	5.619
Jul	20	09 25 53.3	+12 23 14	0.693	09 54 24.1	+14 25 42	1.417	01 35 42.8	+07 03 51	0.898	12 44 39.3	-03 27 18	5.634

GEOCENTRIC PLANET POSITIONS (continued)

Note: positions refer to 0000 WAST

MTH	DAY	MERCURY			VENUS			MARS			JUPITER		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Jul	21	09 26 32.3	+12 05 30	0.681	09 59 03.3	+14 00 18	1.412	01 38 01.5	+07 16 48	0.892	12 45 05.3	-03 30 17	5.649
Jul	22	09 26 53.0	+11 49 22	0.669	10 03 41.4	+13 34 33	1.406	01 40 19.7	+07 29 37	0.886	12 45 31.8	-03 33 19	5.664
Jul	23	09 26 55.3	+11 34 59	0.659	10 08 18.2	+13 08 28	1.400	01 42 37.2	+07 42 20	0.881	12 45 58.8	-03 36 24	5.679
Jul	24	09 26 38.9	+11 22 27	0.648	10 12 53.9	+12 42 03	1.394	01 44 54.2	+07 54 55	0.875	12 46 26.2	-03 39 31	5.693
Jul	25	09 26 03.8	+11 11 54	0.639	10 17 28.5	+12 15 18	1.389	01 47 10.4	+08 07 23	0.870	12 46 54.1	-03 42 42	5.708
Jul	26	09 25 10.2	+11 03 26	0.630	10 22 01.9	+11 48 15	1.383	01 49 26.0	+08 19 44	0.864	12 47 22.5	-03 45 55	5.723
Jul	27	09 23 58.4	+10 57 09	0.622	10 26 34.3	+11 20 55	1.377	01 51 40.9	+08 31 57	0.859	12 47 51.3	-03 49 10	5.737
Jul	28	09 22 28.8	+10 53 07	0.615	10 31 05.6	+10 53 17	1.371	01 53 55.1	+08 44 01	0.853	12 48 20.6	-03 52 28	5.751
Jul	29	09 20 42.3	+10 51 25	0.609	10 35 35.9	+10 25 23	1.365	01 56 08.5	+08 55 58	0.847	12 48 50.2	-03 55 49	5.766
Jul	30	09 18 39.9	+10 52 04	0.603	10 40 05.2	+09 57 13	1.359	01 58 21.1	+09 07 47	0.842	12 49 20.4	-03 59 12	5.780
Jul	31	09 16 23.0	+10 55 05	0.599	10 44 33.5	+09 28 49	1.353	02 00 33.0	+09 19 27	0.836	12 49 51.0	-04 02 38	5.794
Aug	1	09 13 53.1	+11 00 28	0.596	10 49 01.0	+09 00 10	1.347	02 02 44.0	+09 30 60	0.831	12 50 22.0	-04 06 06	5.808
Aug	2	09 11 12.3	+11 08 08	0.594	10 53 27.5	+08 31 17	1.341	02 04 54.1	+09 42 23	0.825	12 50 53.4	-04 09 37	5.822
Aug	3	09 08 22.9	+11 18 00	0.593	10 57 53.1	+08 02 12	1.335	02 07 03.4	+09 53 39	0.820	12 51 25.2	-04 13 10	5.836
Aug	4	09 05 27.6	+11 29 58	0.594	11 02 18.0	+07 32 54	1.328	02 09 11.8	+10 04 45	0.814	12 51 57.5	-04 16 45	5.850
Aug	5	09 02 29.1	+11 43 50	0.596	11 06 42.0	+07 03 25	1.322	02 11 19.2	+10 15 43	0.809	12 52 30.1	-04 20 23	5.864
Aug	6	08 59 30.5	+11 59 24	0.599	11 11 05.3	+06 33 46	1.316	02 13 25.7	+10 26 32	0.803	12 53 03.2	-04 24 03	5.877
Aug	7	08 56 35.2	+12 16 28	0.604	11 15 27.8	+06 03 56	1.310	02 15 31.1	+10 37 12	0.798	12 53 36.7	-04 27 45	5.891
Aug	8	08 53 46.4	+12 34 46	0.610	11 19 49.6	+05 33 57	1.303	02 17 35.6	+10 47 44	0.792	12 54 10.5	-04 31 29	5.904
Aug	9	08 51 07.4	+12 54 00	0.618	11 24 10.8	+05 03 49	1.297	02 19 39.0	+10 58 06	0.787	12 54 44.7	-04 35 15	5.917
Aug	10	08 48 41.5	+13 13 55	0.627	11 28 31.3	+04 33 33	1.291	02 21 41.3	+11 08 20	0.781	12 55 19.4	-04 39 04	5.930
Aug	11	08 46 31.7	+13 34 11	0.638	11 32 51.3	+04 03 10	1.284	02 23 42.5	+11 18 24	0.776	12 55 54.4	-04 42 54	5.943
Aug	12	08 44 40.9	+13 54 32	0.651	11 37 10.7	+03 32 41	1.278	02 25 42.6	+11 28 19	0.770	12 56 29.7	-04 46 46	5.956
Aug	13	08 43 11.7	+14 14 39	0.665	11 41 29.6	+03 02 06	1.271	02 27 41.5	+11 38 06	0.765	12 57 05.4	-04 50 41	5.969
Aug	14	08 42 06.4	+14 34 16	0.680	11 45 47.9	+02 31 25	1.265	02 29 39.2	+11 47 43	0.760	12 57 41.5	-04 54 37	5.981
Aug	15	08 41 26.9	+14 53 06	0.697	11 50 05.9	+02 00 40	1.258	02 31 35.7	+11 57 11	0.754	12 58 18.0	-04 58 35	5.994
Aug	16	08 41 14.8	+15 10 54	0.715	11 54 23.4	+01 29 51	1.252	02 33 31.0	+12 06 30	0.749	12 58 54.7	-05 02 35	6.006
Aug	17	08 41 31.4	+15 27 25	0.735	11 58 40.5	+00 58 60	1.245	02 35 25.0	+12 15 40	0.743	12 59 31.9	-05 06 37	6.018
Aug	18	08 42 17.5	+15 42 24	0.756	12 02 57.3	+00 28 05	1.239	02 37 17.7	+12 24 41	0.738	13 00 09.3	-05 10 40	6.030
Aug	19	08 43 33.7	+15 55 39	0.778	12 07 13.8	-00 02 51	1.232	02 39 09.0	+12 33 33	0.733	13 00 47.1	-05 14 45	6.042
Aug	20	08 45 20.3	+16 06 57	0.801	12 11 30.0	-00 33 48	1.225	02 40 58.9	+12 42 16	0.727	13 01 25.2	-05 18 52	6.054
Aug	21	08 47 37.1	+16 16 06	0.825	12 15 46.0	-01 04 45	1.219	02 42 47.5	+12 50 49	0.722	13 02 03.6	-05 23 00	6.066
Aug	22	08 50 23.9	+16 22 56	0.850	12 20 01.8	-01 35 43	1.212	02 44 34.5	+12 59 13	0.717	13 02 42.4	-05 27 10	6.077
Aug	23	08 53 39.9	+16 27 17	0.876	12 24 17.5	-02 06 39	1.205	02 46 20.1	+13 07 28	0.712	13 03 21.4	-05 31 22	6.089
Aug	24	08 57 24.3	+16 28 59	0.903	12 28 33.1	-02 37 35	1.198	02 48 04.1	+13 15 34	0.706	13 04 00.8	-05 35 35	6.100
Aug	25	09 01 36.0	+16 27 54	0.929	12 32 48.6	-03 08 28	1.192	02 49 46.5	+13 23 30	0.701	13 04 40.5	-05 39 49	6.111
Aug	26	09 06 13.6	+16 23 57	0.957	12 37 04.1	-03 39 18	1.185	02 51 27.2	+13 31 17	0.696	13 05 20.5	-05 44 05	6.122
Aug	27	09 11 15.5	+16 17 02	0.984	12 41 19.6	-04 10 05	1.178	02 53 06.2	+13 38 54	0.691	13 06 00.7	-05 48 22	6.133
Aug	28	09 16 40.0	+16 07 04	1.011	12 45 35.2	-04 40 48	1.171	02 54 43.4	+13 46 21	0.685	13 06 41.3	-05 52 41	6.143
Aug	29	09 22 25.0	+15 54 03	1.038	12 49 50.9	-05 11 26	1.164	02 56 18.9	+13 53 39	0.680	13 07 22.1	-05 57 01	6.154
Aug	30	09 28 28.6	+15 37 58	1.065	12 54 06.7	-05 41 59	1.157	02 57 52.4	+14 00 48	0.675	13 08 03.3	-06 01 23	6.164
Aug	31	09 34 48.6	+15 18 52	1.091	12 58 22.7	-06 12 26	1.150	02 59 24.1	+14 07 46	0.670	13 08 44.7	-06 05 45	6.174
Sep	1	09 41 22.7	+14 56 48	1.117	13 02 38.9	-06 42 47	1.143	03 00 53.7	+14 14 35	0.665	13 09 26.4	-06 10 09	6.184
Sep	2	09 48 08.8	+14 31 52	1.142	13 06 55.3	-07 12 60	1.136	03 02 21.3	+14 21 14	0.659	13 10 08.3	-06 14 34	6.194
Sep	3	09 55 04.7	+14 04 12	1.166	13 11 12.0	-07 43 05	1.129	03 03 46.8	+14 27 44	0.654	13 10 50.6	-06 19 00	6.204
Sep	4	10 02 08.2	+13 33 57	1.188	13 15 29.0	-08 13 01	1.122	03 05 10.2	+14 34 04	0.649	13 11 33.0	-06 23 28	6.213
Sep	5	10 09 17.6	+13 01 17	1.210	13 19 46.3	-08 42 49	1.115	03 06 31.4	+14 40 14	0.644	13 12 15.8	-06 27 56	6.222
Sep	6	10 16 30.8	+12 26 24	1.231	13 24 04.0	-09 12 26	1.108	03 07 50.3	+14 46 15	0.639	13 12 58.8	-06 32 26	6.231
Sep	7	10 23 46.4	+11 49 29	1.250	13 28 22.1	-09 41 52	1.101	03 09 06.9	+14 52 06	0.634	13 13 42.0	-06 36 56	6.240
Sep	8	10 31 02.9	+11 10 44	1.268	13 32 40.6	-10 11 07	1.094	03 10 21.1	+14 57 48	0.629	13 14 25.5	-06 41 28	6.249
Sep	9	10 38 19.1	+10 30 22	1.284	13 36 59.5	-10 40 10	1.087	03 11 33.0	+15 03 20	0.624	13 15 09.2	-06 45 60	6.258
Sep	10	10 45 33.8	+09 48 34	1.300	13 41 18.9	-11 09 00	1.080	03 12 42.3	+15 08 42	0.619	13 15 53.1	-06 50 33	6.266
Sep	11	10 52 46.3	+09 05 32	1.314	13 45 38.8	-11 37 37	1.073	03 13 49.2	+15 13 56	0.615	13 16 37.3	-06 55 07	6.274
Sep	12	10 59 55.9	+08 21 25	1.327	13 49 59.3	-12 05 59	1.066	03 14 53.5	+15 18 59	0.610	13 17 21.6	-06 59 42	6.282
Sep	13	11 07 02.0	+07 36 25	1.339	13 54 20.2	-12 34 07	1.058	03 15 55.2	+15 23 54	0.605	13 18 06.2	-07 04 18	6.290
Sep	14	11 14 04.2	+06 50 41	1.349	13 58 41.7	-13 01 59	1.051	03 16 54.2	+15 28 39	0.600	13 18 51.0	-07 08 54	6.298
Sep	15	11 21 02.3	+06 04 21	1.359	14 03 03.8	-13 29 34	1.044	03 17 50.5	+15 33 15	0.595	13 19 36.0	-07 13 31	6.306
Sep	16	11 27 56.0	+05 17 34	1.367	14 07 26.5	-13 56 53	1.037	03 18 44.0	+15 37 42	0.591	13 20 21.2	-07 18 08	6.313
Sep	17	11 34 45.2	+04 30 25	1.375	14 11 49.8	-14 23 54	1.029	03 19 34.7	+15 41 60	0.586	13 21 06.6	-07 22 47	6.320
Sep	18	11 41 30.0	+03 43 03	1.382	14 16 13.7	-14 50 37	1.022	03 20 22.5	+15 46 08	0.582	13 21 52.2	-07 27 25	6.327
Sep	19	11 48 10.3	+02 55 32	1.387	14 20 38.3	-15 17 01	1.015	03 21 07.3	+15 50 07	0.577	13 22 38.0	-07 32 05	6.334
Sep	20	11 54 46.2	+02 07 57	1.392	14 25 03.6	-15 43 06	1.007	03 21 49.1	+15 53 57	0.572	13 23 24.0	-07 36 45	6.340
Sep	21	12 01 17.9	+01 20 25	1.396	14 29 29.5	-16 08 50	1.000	03 22 27.9	+15 57 37	0.568	13 24 10.1	-07 41 25	6.347
Sep	22	12 07 45.4	+00 32 58	1.399	14 33 56.1	-16 34 14	0.993	03 23 03.5	+16 01 08	0.564	13 24 56.4	-07 46 06	6.353
Sep	23	12 14 08.9	-00 14 20	1.401	14 38 23.5	-16 59 15	0.985	03 23 35.9	+16 04 30	0.559	13 25 42.9	-07 50 47	6.359
Sep	24	12 20 28.7	-01 01 25	1.403	14 42 51.6	-17 23 55	0.978	03 24 05.1	+16 07 42	0.555	13 26 29.6	-07 55 29	6.364
Sep	25	12 26 44.8	-01 48 14	1.404	14 47 20.4	-17 48 12	0.971	03 24 30.9	+16 10 44	0.551	13 27 16.4	-08 00 11	6.370

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	MERCURY			VENUS			MARS			JUPITER		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Sep	26	12 32 57.4	-02 34 44	1.404	14 51 49.9	-18 12 06	0.963	03 24 53.3	+16 13 37	0.547	13 28 03.4	-08 04 53	6.375
Sep	27	12 39 06.9	-03 20 53	1.404	14 56 20.2	-18 35 36	0.956	03 25 12.2	+16 16 20	0.543	13 28 50.6	-08 09 36	6.381
Sep	28	12 45 13.2	-04 06 38	1.403	15 00 51.2	-18 58 41	0.949	03 25 27.7	+16 18 53	0.538	13 29 37.9	-08 14 19	6.386
Sep	29	12 51 16.7	-04 51 57	1.402	15 05 23.0	-19 21 20	0.941	03 25 39.7	+16 21 17	0.535	13 30 25.3	-08 19 02	6.390
Sep	30	12 57 17.5	-05 36 49	1.399	15 09 55.5	-19 43 34	0.934	03 25 48.0	+16 23 31	0.531	13 31 12.9	-08 23 45	6.395
Oct	1	13 03 15.9	-06 21 12	1.397	15 14 28.7	-20 05 21	0.926	03 25 52.8	+16 25 35	0.527	13 32 00.6	-08 28 29	6.399
Oct	2	13 09 11.8	-07 05 03	1.394	15 19 02.7	-20 26 41	0.919	03 25 53.9	+16 27 29	0.523	13 32 48.5	-08 33 12	6.404
Oct	3	13 15 05.7	-07 48 22	1.390	15 23 37.3	-20 47 33	0.911	03 25 51.3	+16 29 13	0.519	13 33 36.5	-08 37 56	6.407
Oct	4	13 20 57.5	-08 31 07	1.386	15 28 12.6	-21 07 56	0.904	03 25 45.0	+16 30 48	0.516	13 34 24.7	-08 42 40	6.411
Oct	5	13 26 47.5	-09 13 16	1.381	15 32 48.6	-21 27 51	0.896	03 25 35.0	+16 32 13	0.512	13 35 12.9	-08 47 24	6.415
Oct	6	13 32 35.7	-09 54 49	1.376	15 37 25.2	-21 47 16	0.889	03 25 21.3	+16 33 27	0.509	13 36 01.3	-08 52 08	6.418
Oct	7	13 38 22.4	-10 35 43	1.370	15 42 02.4	-22 06 10	0.881	03 25 03.9	+16 34 32	0.506	13 36 49.7	-08 56 51	6.421
Oct	8	13 44 07.5	-11 15 58	1.364	15 46 40.2	-22 24 34	0.874	03 24 42.7	+16 35 28	0.502	13 37 38.3	-09 01 35	6.424
Oct	9	13 49 51.3	-11 55 32	1.357	15 51 18.5	-22 42 26	0.866	03 24 17.9	+16 36 13	0.499	13 38 27.0	-09 06 18	6.427
Oct	10	13 55 33.8	-12 34 24	1.350	15 55 57.2	-22 59 47	0.859	03 23 49.5	+16 36 49	0.496	13 39 15.8	-09 11 02	6.429
Oct	11	14 01 15.2	-13 12 34	1.343	16 00 36.5	-23 16 35	0.851	03 23 17.4	+16 37 15	0.494	13 40 04.6	-09 15 45	6.432
Oct	12	14 06 55.3	-13 49 58	1.335	16 05 16.1	-23 32 50	0.844	03 22 41.7	+16 37 31	0.491	13 40 53.6	-09 20 28	6.434
Oct	13	14 12 34.4	-14 26 37	1.326	16 09 56.1	-23 48 31	0.836	03 22 02.5	+16 37 38	0.488	13 41 42.6	-09 25 10	6.436
Oct	14	14 18 12.4	-15 02 29	1.317	16 14 36.4	-24 03 39	0.828	03 21 19.9	+16 37 35	0.486	13 42 31.7	-09 29 53	6.437
Oct	15	14 23 49.3	-15 37 33	1.308	16 19 16.9	-24 18 12	0.821	03 20 33.8	+16 37 23	0.483	13 43 20.9	-09 34 34	6.439
Oct	16	14 29 25.2	-16 11 47	1.298	16 23 57.6	-24 32 10	0.813	03 19 44.3	+16 37 01	0.481	13 44 10.1	-09 39 16	6.440
Oct	17	14 34 60.0	-16 45 11	1.288	16 28 38.4	-24 45 34	0.806	03 18 51.6	+16 36 29	0.479	13 44 59.4	-09 43 57	6.441
Oct	18	14 40 33.6	-17 17 42	1.277	16 33 19.3	-24 58 22	0.798	03 17 55.7	+16 35 49	0.477	13 45 48.8	-09 48 38	6.442
Oct	19	14 46 06.0	-17 49 20	1.266	16 38 00.2	-25 10 34	0.790	03 16 56.6	+16 34 58	0.475	13 46 38.2	-09 53 18	6.442
Oct	20	14 51 37.0	-18 20 02	1.254	16 42 41.1	-25 22 10	0.783	03 15 54.6	+16 33 58	0.473	13 47 27.7	-09 57 58	6.443
Oct	21	14 57 06.6	-18 49 48	1.242	16 47 21.8	-25 33 09	0.775	03 14 49.6	+16 32 49	0.472	13 48 17.3	-10 02 38	6.443
Oct	22	15 02 34.5	-19 18 35	1.229	16 52 02.3	-25 43 32	0.768	03 13 41.8	+16 31 31	0.470	13 49 06.8	-10 07 16	6.443
Oct	23	15 08 00.6	-19 46 22	1.216	16 56 42.6	-25 53 18	0.760	03 12 31.3	+16 30 04	0.469	13 49 56.4	-10 11 55	6.443
Oct	24	15 13 24.5	-20 13 08	1.202	17 01 22.5	-26 02 27	0.752	03 11 18.3	+16 28 29	0.468	13 50 46.1	-10 16 32	6.442
Oct	25	15 18 45.9	-20 38 49	1.188	17 06 02.0	-26 10 59	0.745	03 10 02.8	+16 26 44	0.467	13 51 35.8	-10 21 10	6.441
Oct	26	15 24 04.5	-21 03 25	1.173	17 10 41.0	-26 18 54	0.737	03 08 45.2	+16 24 52	0.466	13 52 25.5	-10 25 46	6.440
Oct	27	15 29 19.9	-21 26 53	1.158	17 15 19.4	-26 26 11	0.729	03 07 25.5	+16 22 51	0.465	13 53 15.2	-10 30 22	6.439
Oct	28	15 34 31.5	-21 49 12	1.142	17 19 57.1	-26 32 51	0.722	03 06 03.8	+16 20 44	0.465	13 54 05.0	-10 34 57	6.438
Oct	29	15 39 38.7	-22 10 17	1.126	17 24 34.1	-26 38 53	0.714	03 04 40.5	+16 18 29	0.464	13 54 54.7	-10 39 31	6.436
Oct	30	15 44 40.9	-22 30 08	1.109	17 29 10.2	-26 44 17	0.707	03 03 15.7	+16 16 07	0.464	13 55 44.5	-10 44 05	6.435
Oct	31	15 49 37.3	-22 48 42	1.092	17 33 45.3	-26 49 04	0.699	03 01 49.6	+16 13 40	0.464	13 56 34.3	-10 48 38	6.433
Nov	1	15 54 27.0	-23 05 55	1.075	17 38 19.3	-26 53 14	0.691	03 00 22.4	+16 11 07	0.464	13 57 24.0	-10 53 09	6.430
Nov	2	15 59 09.1	-23 21 45	1.056	17 42 52.2	-26 56 46	0.684	02 58 54.3	+16 08 29	0.465	13 58 13.8	-10 57 41	6.428
Nov	3	16 03 42.2	-23 36 09	1.038	17 47 23.8	-26 59 40	0.676	02 57 25.6	+16 05 47	0.465	13 59 03.5	-11 02 11	6.425
Nov	4	16 08 05.3	-23 49 03	1.019	17 51 54.0	-27 01 58	0.668	02 55 56.5	+16 03 01	0.466	13 59 53.2	-11 06 40	6.422
Nov	5	16 12 16.8	-24 00 23	0.999	17 56 22.7	-27 03 38	0.661	02 54 27.1	+16 00 12	0.467	14 00 42.9	-11 11 08	6.419
Nov	6	16 16 14.9	-24 10 05	0.979	18 00 49.7	-27 04 42	0.653	02 52 57.8	+15 57 21	0.468	14 01 32.6	-11 15 35	6.416
Nov	7	16 19 58.0	-24 18 06	0.959	18 05 15.0	-27 05 09	0.646	02 51 28.8	+15 54 29	0.469	14 02 22.2	-11 20 02	6.413
Nov	8	16 23 23.9	-24 24 18	0.938	18 09 38.4	-27 05 00	0.638	02 50 00.2	+15 51 36	0.470	14 03 11.8	-11 24 27	6.409
Nov	9	16 26 30.3	-24 28 39	0.917	18 13 59.7	-27 04 16	0.630	02 48 32.2	+15 48 43	0.472	14 04 01.4	-11 28 51	6.405
Nov	10	16 29 14.7	-24 30 60	0.896	18 18 19.0	-27 02 55	0.623	02 47 05.2	+15 45 51	0.474	14 04 50.8	-11 33 13	6.401
Nov	11	16 31 34.5	-24 31 16	0.875	18 22 35.9	-27 01 00	0.615	02 45 39.3	+15 42 60	0.476	14 05 40.2	-11 37 35	6.396
Nov	12	16 33 26.7	-24 29 18	0.854	18 26 50.5	-26 58 31	0.608	02 44 14.6	+15 40 11	0.478	14 06 29.6	-11 41 56	6.392
Nov	13	16 34 48.2	-24 24 60	0.833	18 31 02.4	-26 55 27	0.600	02 42 51.4	+15 37 25	0.480	14 07 18.9	-11 46 15	6.387
Nov	14	16 35 36.1	-24 18 10	0.813	18 35 11.7	-26 51 50	0.592	02 41 29.8	+15 34 43	0.483	14 08 08.1	-11 50 33	6.382
Nov	15	16 35 47.4	-24 08 41	0.793	18 39 18.2	-26 47 40	0.585	02 40 10.0	+15 32 04	0.485	14 08 57.2	-11 54 50	6.377
Nov	16	16 35 19.2	-23 56 22	0.773	18 43 21.8	-26 42 58	0.577	02 38 52.2	+15 29 31	0.488	14 09 46.3	-11 59 05	6.371
Nov	17	16 34 09.5	-23 41 03	0.755	18 47 22.2	-26 37 45	0.570	02 37 36.4	+15 27 03	0.491	14 10 35.3	-12 03 20	6.366
Nov	18	16 32 16.7	-23 22 38	0.738	18 51 19.5	-26 31 60	0.562	02 36 22.9	+15 24 40	0.495	14 11 24.1	-12 07 33	6.360
Nov	19	16 29 40.6	-23 01 00	0.722	18 55 13.4	-26 25 45	0.555	02 35 11.7	+15 22 24	0.498	14 12 12.9	-12 11 44	6.354
Nov	20	16 26 22.2	-22 36 11	0.709	18 59 03.8	-26 19 01	0.548	02 34 02.9	+15 20 16	0.501	14 13 01.6	-12 15 54	6.348
Nov	21	16 22 24.6	-22 08 17	0.697	19 02 50.6	-26 11 48	0.540	02 32 56.7	+15 18 14	0.505	14 13 50.2	-12 20 03	6.341
Nov	22	16 17 52.7	-21 37 34	0.688	19 06 33.6	-26 04 07	0.533	02 31 53.2	+15 16 21	0.509	14 14 38.6	-12 24 11	6.335
Nov	23	16 12 53.6	-21 04 30	0.682	19 10 12.7	-25 55 58	0.525	02 30 52.5	+15 14 37	0.513	14 15 26.9	-12 28 16	6.328
Nov	24	16 07 36.1	-20 29 45	0.678	19 13 47.8	-25 47 24	0.518	02 29 54.7	+15 13 02	0.517	14 16 15.2	-12 32 21	6.321
Nov	25	16 02 10.4	-19 54 09	0.678	19 17 18.6	-25 38 24	0.511	02 28 59.8	+15 11 37	0.522	14 17 03.2	-12 36 24	6.313
Nov	26	15 56 47.6	-19 18 43	0.681	19 20 45.1	-25 28 60	0.503	02 28 08.0	+15 10 21	0.526	14 17 51.2	-12 40 25	6.306
Nov	27	15 51 38.4	-18 44 27	0.687	19 24 07.0	-25 19 11	0.496	02 27 19.2	+15 09 16	0.531	14 18 39.0	-12 44 25	6.298
Nov	28	15 46 52.7	-18 12 25	0.696	19 27 24.2	-25 09 01	0.489	02 26 33.6	+15 08 22	0.536	14 19 26.6	-12 48 23	6.290
Nov	29	15 42 38.8	-17 43 30	0.708	19 30 36.6	-24 58 28	0.482	02 25 51.2	+15 07 39	0.541	14 20 14.1	-12 52 20	6.282
Nov	30	15 39 03.0	-17 18 26	0.723	19 33 43.9	-24 47 35	0.475	02 25 12.0	+15 07 07	0.546	14 21 01.5	-12 56 15	6.274
Dec	1	15 36 09.7	-16 57 44	0.740	19 36 46.0	-24 36 22	0.467	02 24 36.1	+15 06 48	0.551	14 21 48.6	-13 00 08	6.266

GEOCENTRIC PLANET POSITIONS (continued)

Note: positions refer to 0000 WAST

MTH	DAY	MERCURY							VENUS							MARS							JUPITER						
		RA			Declination			Dist. (AU)	RA			Declination			Dist. (AU)	RA			Declination			Dist. (AU)	RA			Declination			Dist. (AU)
		h	m	s	°	′	″		h	m	s	°	′	″		h	m	s	°	′	″		h	m	s	°	′	″	
Dec	2	15	34	00.9	-16	41	41	0.759	19	39	42.7	-24	24	51	0.460	02	24	03.5	+15	06	40	0.557	14	22	35.6	-13	03	60	6.257
Dec	3	15	32	37.2	-16	30	19	0.779	19	42	33.7	-24	13	01	0.453	02	23	34.3	+15	06	44	0.562	14	23	22.4	-13	07	50	6.248
Dec	4	15	31	57.6	-16	23	33	0.801	19	45	19.0	-24	00	56	0.446	02	23	08.4	+15	07	01	0.568	14	24	09.0	-13	11	38	6.239
Dec	5	15	32	00.2	-16	21	06	0.824	19	47	58.2	-23	48	35	0.439	02	22	45.9	+15	07	31	0.574	14	24	55.5	-13	15	24	6.230
Dec	6	15	32	42.3	-16	22	40	0.847	19	50	31.1	-23	36	00	0.433	02	22	26.7	+15	08	13	0.580	14	25	41.7	-13	19	08	6.220
Dec	7	15	34	00.8	-16	27	49	0.871	19	52	57.6	-23	23	12	0.426	02	22	10.8	+15	09	08	0.586	14	26	27.7	-13	22	51	6.211
Dec	8	15	35	52.7	-16	36	09	0.896	19	55	17.4	-23	10	13	0.419	02	21	58.3	+15	10	15	0.592	14	27	13.5	-13	26	32	6.201
Dec	9	15	38	14.8	-16	47	14	0.920	19	57	30.2	-22	57	03	0.412	02	21	49.1	+15	11	35	0.598	14	27	59.0	-13	30	10	6.191
Dec	10	15	41	04.0	-17	00	38	0.944	19	59	35.9	-22	43	44	0.406	02	21	43.2	+15	13	08	0.605	14	28	44.4	-13	33	47	6.181
Dec	11	15	44	17.6	-17	16	00	0.968	20	01	34.1	-22	30	17	0.399	02	21	40.5	+15	14	52	0.611	14	29	29.5	-13	37	22	6.171
Dec	12	15	47	52.9	-17	32	58	0.991	20	03	24.7	-22	16	43	0.393	02	21	41.0	+15	16	50	0.618	14	30	14.3	-13	40	55	6.160
Dec	13	15	51	47.5	-17	51	11	1.014	20	05	07.4	-22	03	04	0.386	02	21	44.6	+15	18	59	0.625	14	30	59.0	-13	44	26	6.149
Dec	14	15	55	59.4	-18	10	22	1.036	20	06	41.9	-21	49	21	0.380	02	21	51.4	+15	21	20	0.632	14	31	43.3	-13	47	55	6.139
Dec	15	16	00	26.6	-18	30	17	1.058	20	08	08.1	-21	35	36	0.374	02	22	01.2	+15	23	52	0.639	14	32	27.4	-13	51	22	6.128
Dec	16	16	05	07.6	-18	50	39	1.079	20	09	25.6	-21	21	48	0.368	02	22	14.1	+15	26	36	0.646	14	33	11.3	-13	54	47	6.116
Dec	17	16	10	00.9	-19	11	18	1.100	20	10	34.3	-21	08	01	0.362	02	22	29.9	+15	29	32	0.653	14	33	54.8	-13	58	10	6.105
Dec	18	16	15	05.2	-19	32	02	1.120	20	11	33.9	-20	54	15	0.356	02	22	48.6	+15	32	38	0.660	14	34	38.1	-14	01	31	6.094
Dec	19	16	20	19.4	-19	52	41	1.139	20	12	24.2	-20	40	31	0.350	02	23	10.3	+15	35	55	0.668	14	35	21.1	-14	04	50	6.082
Dec	20	16	25	42.5	-20	13	08	1.157	20	13	05.0	-20	26	50	0.345	02	23	34.7	+15	39	23	0.675	14	36	03.9	-14	08	07	6.070
Dec	21	16	31	13.7	-20	33	14	1.175	20	13	36.1	-20	13	15	0.339	02	24	01.9	+15	43	01	0.683	14	36	46.3	-14	11	22	6.058
Dec	22	16	36	52.2	-20	52	53	1.192	20	13	57.3	-19	59	45	0.334	02	24	31.9	+15	46	50	0.691	14	37	28.4	-14	14	34	6.046
Dec	23	16	42	37.4	-21	11	59	1.209	20	14	08.5	-19	46	23	0.328	02	25	04.6	+15	50	48	0.698	14	38	10.2	-14	17	44	6.034
Dec	24	16	48	28.7	-21	30	27	1.224	20	14	09.4	-19	33	09	0.323	02	25	39.9	+15	54	56	0.706	14	38	51.7	-14	20	52	6.021
Dec	25	16	54	25.6	-21	48	12	1.240	20	14	00.1	-19	20	04	0.318	02	26	17.8	+15	59	14	0.714	14	39	32.9	-14	23	58	6.008
Dec	26	17	00	27.6	-22	05	10	1.254	20	13	40.3	-19	07	10	0.314	02	26	58.3	+16	03	40	0.722	14	40	13.7	-14	27	02	5.996
Dec	27	17	06	34.5	-22	21	18	1.268	20	13	10.1	-18	54	29	0.309	02	27	41.3	+16	08	16	0.730	14	40	54.2	-14	30	03	5.983
Dec	28	17	12	45.7	-22	36	32	1.281	20	12	29.5	-18	41	60	0.305	02	28	26.8	+16	13	01	0.738	14	41	34.3	-14	33	02	5.970
Dec	29	17	19	01.0	-22	50	49	1.293	20	11	38.3	-18	29	45	0.301	02	29	14.7	+16	17	54	0.747	14	42	14.1	-14	35	59	5.957
Dec	30	17	25	20.2	-23	04	06	1.305	20	10	36.9	-18	17	45	0.297	02	30	05.0	+16	22	55	0.755	14	42	53.5	-14	38	54	5.943
Dec	31	17	31	42.9	-23	16	21	1.316	20	09	25.3	-18	06	01	0.293	02	30	57.7	+16	28	05	0.763	14	43	32.5	-14	41	46	5.930

GEOCENTRIC PLANET POSITIONS (EPOCH J2000.0)

Note: positions refer to 0000 WAST

MTH	DAY	SATURN							URANUS							NEPTUNE							PLUTO						
		RA			Declination			Dist. (AU)	RA			Declination			Dist. (AU)	RA			Declination			Dist. (AU)	RA			Declination			Dist. (AU)
		h	m	s	°	′	″		h	m	s	°	′	″		h	m	s	°	′	″		h	m	s	°	′	″	
Jan	1	07	47	17.0	+21	08	12	8.103	22	24	01.8	-10	47	46	20.626	21	05	03.5	-16	46	48	30.881	17	29	49.2	-15	11	51	31.818
Jan	2	07	46	57.2	+21	09	09	8.099	22	24	10.8	-10	46	53	20.640	21	05	11.4	-16	46	14	30.890	17	29	58.1	-15	11	58	31.813
Jan	3	07	46	37.3	+21	10	06	8.096	22	24	19.9	-10	45	59	20.653	21	05	19.4	-16	45	40	30.899	17	30	06.9	-15	12	06	31.808
Jan	4	07	46	17.2	+21	11	04	8.092	22	24	29.1	-10	45	04	20.667	21	05	27.5	-16	45	06	30.908	17	30	15.8	-15	12	13	31.802
Jan	5	07	45	56.9	+21	12	01	8.089	22	24	38.5	-10	44	08	20.680	21	05	35.6	-16	44	31	30.917	17	30	24.5	-15	12	19	31.797
Jan	6	07	45	36.6	+21	12	59	8.086	22	24	48.0	-10	43	12	20.693	21	05	43.8	-16	43	56	30.925	17	30	33.3	-15	12	26	31.791
Jan	7	07	45	16.1	+21	13	57	8.084	22	24	57.6	-10	42	14	20.706	21	05	52.0	-16	43	21	30.934	17	30	41.9	-15	12	32	31.784
Jan	8	07	44	55.6	+21	14	55	8.082	22	25	07.4	-10	41	16	20.719	21	06	00.4	-16	42	46	30.942	17	30	50.6	-15	12	37	31.778
Jan	9	07	44	35.0	+21	15	53	8.080	22	25	17.3	-10	40	18	20.732	21	06	08.7	-16	42	10	30.949	17	30	59.1	-15	12	43	31.771
Jan	10	07	44	14.2	+21	16	51	8.078	22	25	27.3	-10	39	18	20.744	21	06	17.2	-16	41	34	30.957	17	31	07.7	-15	12	48	31.764
Jan	11	07	43	53.5	+21	17	49	8.077	22	25	37.5	-10	38	18	20.756	21	06	25.6	-16	40	58	30.964	17	31	16.1	-15	12	53	31.757
Jan	12	07	43	32.7	+21	18	47	8.076	22	25	47.8	-10	37	17	20.768	21	06	34.2	-16	40	22	30.971	17	31	24.5	-15	12	57	31.749
Jan	13	07	43	11.8	+21	19	45	8.076	22	25	58.2	-10	36	15	20.780	21	06	42.7	-16	39	45	30.977	17	31	32.9	-15	13	01	31.741
Jan	14	07	42	51.0	+21	20	43	8.076	22	26	08.7	-10	35	13	20.791	21	06	51.4	-16	39	08	30.984	17	31	41.2	-15	13	05	31.733
Jan	15	07	42	30.1	+21	21	40	8.076	22	26	19.3	-10	34	10	20.803	21	07	00.0	-16	38	31	30.990	17	31	49.4	-15	13	09	31.725
Jan	16	07	42	09.2	+21	22	38	8.076	22	26	30.0	-10	33	07	20.814	21	07	08.7	-16	37	54	30.995	17	31	57.6	-15	13	12	31.716
Jan	17	07	41	48.4	+21	23	35	8.077	22	26	40.9	-10	32	03	20.825	21	07	17.5	-16	37	16	31.001	17	32	05.6	-15	13	15	31.707
Jan	18	07	41	27.6	+21	24	32	8.078	22	26	51.8	-10	30	58	20.835	21	07	26.3	-16	36	39	31.006	17	32	13.7	-15	13	18	31.698
Jan	19	07	41	06.8	+21	25	29	8.079	22	27	02.9	-10	29	52	20.846	21	07	35.1	-16	36	01	31.011	17	32	21.6	-15	13	20	31.689
Jan	20	07	40	46.1	+21	26	25	8.081	22	27	14.0	-10	28	47	20.856	21	07	43.9	-16	35	23	31.016	17	32	29.5	-15	13	22	31.679
Jan	21	07	40	25.5	+21	27	21	8.083	22	27	25.3	-10	27	40	20.866	21	07	52.8	-16	34	45	31.020	17	32	37.3	-15	13	23	31.670
Jan	22	07	40	04.9	+21	28	17	8.085	22	27	36.6	-10	26	33	20.876	21	08	01.7	-16	34	06	31.024	17	32	45.0	-15	13	25	31.660
Jan	23	07	39	44.4	+21	29	12	8.088	22	27	48.1	-10	25	25	20.885	21	08	10.7	-16	33	28	31.028	17	32	52.6	-15	13	26	31.649
Jan	24	07	39	24.1	+21	30	07	8.091	22	27	59.6	-10	24	17	20.894	21	08	19.6	-16	32	49	31.031	17	33	00.2	-15	13	27	31.639
Jan	25	07	39	03.8	+21	31	01	8.094	22	28	11.2	-10	23	09	20.903	21	08	28.6	-16	32	11	31.035	17	33	07.6	-15	13	28	31.628
Jan	26	07	38	43.6	+21	31	55	8.098	22	28	22.9	-10	21	60	20.912	21	08	37.6	-16	31	32	31.038	17	33	15.0	-15	13	28	31.617
Jan	27	07	38	23.6	+21	32	48	8.102	22	28	34.7	-10	20	50	20.920	21	08	46.6	-16	30	53	31.040	17	33	22.3	-15	13	28	31.606
Jan	28	07	38	03.8	+21	33	41	8.106	22	28	46.6	-10	19	40	20.929	21	08	55.7	-16	30	14	31.043	17	33	29.5	-15	13	27	31.595
Jan	29	07	37	44.1	+21	34	34	8.110	22	28	58.5	-10	18	30	20.937	21	09	04.7	-16	29	35	31.045	17	33	36.7	-15	13	27	31.583
Jan	30	07	37	24.6	+21	35	26	8.115	22	29	10.5	-10	17	19	20.944	21	09	13.8	-16	28	56	31.047	17	33	43.7	-15	13	26	31.571

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	SATURN			URANUS			NEPTUNE			PLUTO		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Jan	31	07 37 05.2	+21 36 17	8.120	22 29 22.6	-10 16 07	20.952	21 09 22.9	-16 28 16	31.048	17 33 50.6	-15 13 25	31.559
Feb	1	07 36 46.0	+21 37 07	8.126	22 29 34.8	-10 14 56	20.959	21 09 32.0	-16 27 37	31.049	17 33 57.5	-15 13 24	31.547
Feb	2	07 36 27.1	+21 37 58	8.131	22 29 47.0	-10 13 44	20.966	21 09 41.0	-16 26 58	31.050	17 34 04.2	-15 13 22	31.535
Feb	3	07 36 08.3	+21 38 47	8.137	22 29 59.3	-10 12 31	20.973	21 09 50.1	-16 26 18	31.051	17 34 10.9	-15 13 20	31.522
Feb	4	07 35 49.8	+21 39 36	8.144	22 30 11.6	-10 11 18	20.979	21 09 59.2	-16 25 39	31.051	17 34 17.4	-15 13 18	31.510
Feb	5	07 35 31.5	+21 40 24	8.150	22 30 24.0	-10 10 05	20.985	21 10 08.3	-16 24 59	31.051	17 34 23.9	-15 13 15	31.497
Feb	6	07 35 13.5	+21 41 11	8.157	22 30 36.5	-10 08 52	20.991	21 10 17.4	-16 24 20	31.051	17 34 30.2	-15 13 13	31.484
Feb	7	07 34 55.7	+21 41 58	8.164	22 30 49.0	-10 07 38	20.997	21 10 26.5	-16 23 40	31.050	17 34 36.5	-15 13 10	31.470
Feb	8	07 34 38.1	+21 42 44	8.172	22 31 01.6	-10 06 24	21.002	21 10 35.6	-16 23 01	31.050	17 34 42.6	-15 13 06	31.457
Feb	9	07 34 20.9	+21 43 29	8.179	22 31 14.2	-10 05 09	21.007	21 10 44.7	-16 22 21	31.048	17 34 48.7	-15 13 03	31.443
Feb	10	07 34 03.9	+21 44 13	8.187	22 31 26.9	-10 03 54	21.012	21 10 53.7	-16 21 42	31.047	17 34 54.6	-15 12 59	31.430
Feb	11	07 33 47.2	+21 44 57	8.196	22 31 39.6	-10 02 39	21.017	21 11 02.8	-16 21 02	31.045	17 35 00.4	-15 12 55	31.416
Feb	12	07 33 30.9	+21 45 39	8.204	22 31 52.3	-10 01 24	21.021	21 11 11.8	-16 20 23	31.043	17 35 06.1	-15 12 51	31.402
Feb	13	07 33 14.8	+21 46 21	8.213	22 32 05.1	-10 00 09	21.025	21 11 20.9	-16 19 43	31.041	17 35 11.7	-15 12 47	31.387
Feb	14	07 32 59.1	+21 47 02	8.222	22 32 17.9	-09 58 53	21.028	21 11 29.8	-16 19 04	31.039	17 35 17.2	-15 12 42	31.373
Feb	15	07 32 43.7	+21 47 43	8.231	22 32 30.8	-09 57 38	21.032	21 11 38.8	-16 18 25	31.036	17 35 22.5	-15 12 37	31.358
Feb	16	07 32 28.6	+21 48 22	8.241	22 32 43.6	-09 56 22	21.035	21 11 47.8	-16 17 46	31.033	17 35 27.8	-15 12 32	31.344
Feb	17	07 32 13.9	+21 49 01	8.251	22 32 56.5	-09 55 06	21.038	21 11 56.7	-16 17 07	31.029	17 35 32.9	-15 12 27	31.329
Feb	18	07 31 59.6	+21 49 38	8.261	22 33 09.5	-09 53 49	21.040	21 12 05.6	-16 16 28	31.025	17 35 37.9	-15 12 22	31.314
Feb	19	07 31 45.6	+21 50 15	8.271	22 33 22.4	-09 52 33	21.043	21 12 14.5	-16 15 49	31.021	17 35 42.8	-15 12 16	31.299
Feb	20	07 31 31.9	+21 50 51	8.282	22 33 35.4	-09 51 17	21.045	21 12 23.3	-16 15 10	31.017	17 35 47.5	-15 12 10	31.284
Feb	21	07 31 18.7	+21 51 26	8.293	22 33 48.3	-09 50 00	21.046	21 12 32.1	-16 14 32	31.013	17 35 52.2	-15 12 04	31.268
Feb	22	07 31 05.8	+21 51 60	8.304	22 34 01.3	-09 48 44	21.048	21 12 40.9	-16 13 53	31.008	17 35 56.7	-15 11 57	31.253
Feb	23	07 30 53.4	+21 52 33	8.315	22 34 14.3	-09 47 27	21.049	21 12 49.6	-16 13 15	31.003	17 36 01.1	-15 11 51	31.238
Feb	24	07 30 41.3	+21 53 05	8.326	22 34 27.3	-09 46 11	21.050	21 12 58.3	-16 12 37	30.997	17 36 05.4	-15 11 44	31.222
Feb	25	07 30 29.6	+21 53 36	8.338	22 34 40.3	-09 44 54	21.051	21 13 06.9	-16 11 59	30.992	17 36 09.5	-15 11 37	31.206
Feb	26	07 30 18.3	+21 54 06	8.350	22 34 53.3	-09 43 37	21.051	21 13 15.5	-16 11 21	30.986	17 36 13.5	-15 11 30	31.191
Feb	27	07 30 07.4	+21 54 35	8.362	22 35 06.3	-09 42 21	21.051	21 13 24.1	-16 10 44	30.980	17 36 17.4	-15 11 23	31.175
Feb	28	07 29 57.0	+21 55 04	8.374	22 35 19.3	-09 41 04	21.051	21 13 32.6	-16 10 06	30.973	17 36 21.2	-15 11 16	31.159
Mar	1	07 29 46.9	+21 55 31	8.387	22 35 32.3	-09 39 47	21.050	21 13 41.0	-16 09 29	30.966	17 36 24.8	-15 11 08	31.143
Mar	2	07 29 37.3	+21 55 57	8.400	22 35 45.2	-09 38 31	21.049	21 13 49.5	-16 08 52	30.959	17 36 28.3	-15 11 01	31.127
Mar	3	07 29 28.1	+21 56 23	8.413	22 35 58.2	-09 37 14	21.048	21 13 57.8	-16 08 15	30.952	17 36 31.7	-15 10 53	31.110
Mar	4	07 29 19.4	+21 56 47	8.426	22 36 11.1	-09 35 58	21.047	21 14 06.1	-16 07 39	30.945	17 36 34.9	-15 10 45	31.094
Mar	5	07 29 11.1	+21 57 11	8.439	22 36 24.1	-09 34 42	21.045	21 14 14.4	-16 07 02	30.937	17 36 38.1	-15 10 36	31.078
Mar	6	07 29 03.2	+21 57 33	8.452	22 36 37.0	-09 33 26	21.043	21 14 22.5	-16 06 26	30.929	17 36 41.1	-15 10 28	31.062
Mar	7	07 28 55.8	+21 57 54	8.466	22 36 49.9	-09 32 10	21.041	21 14 30.7	-16 05 50	30.921	17 36 43.9	-15 10 20	31.045
Mar	8	07 28 48.8	+21 58 15	8.480	22 37 02.7	-09 30 54	21.039	21 14 38.7	-16 05 15	30.912	17 36 46.6	-15 10 11	31.029
Mar	9	07 28 42.3	+21 58 34	8.494	22 37 15.6	-09 29 38	21.036	21 14 46.7	-16 04 40	30.903	17 36 49.2	-15 10 02	31.012
Mar	10	07 28 36.2	+21 58 53	8.508	22 37 28.4	-09 28 23	21.033	21 14 54.7	-16 04 04	30.894	17 36 51.6	-15 09 54	30.996
Mar	11	07 28 30.6	+21 59 10	8.522	22 37 41.2	-09 27 07	21.030	21 15 02.5	-16 03 30	30.885	17 36 54.0	-15 09 44	30.979
Mar	12	07 28 25.5	+21 59 27	8.537	22 37 53.9	-09 25 52	21.026	21 15 10.3	-16 02 55	30.876	17 36 56.1	-15 09 35	30.963
Mar	13	07 28 20.8	+21 59 42	8.551	22 38 06.6	-09 24 37	21.022	21 15 18.1	-16 02 21	30.866	17 36 58.2	-15 09 26	30.946
Mar	14	07 28 16.6	+21 59 56	8.566	22 38 19.2	-09 23 23	21.018	21 15 25.7	-16 01 47	30.856	17 37 00.1	-15 09 17	30.930
Mar	15	07 28 12.9	+22 00 10	8.581	22 38 31.8	-09 22 09	21.014	21 15 33.3	-16 01 14	30.846	17 37 01.8	-15 09 08	30.913
Mar	16	07 28 09.7	+22 00 22	8.596	22 38 44.4	-09 20 54	21.009	21 15 40.8	-16 00 41	30.835	17 37 03.5	-15 08 58	30.896
Mar	17	07 28 06.9	+22 00 33	8.611	22 38 56.9	-09 19 41	21.004	21 15 48.2	-16 00 08	30.825	17 37 05.0	-15 08 49	30.880
Mar	18	07 28 04.6	+22 00 43	8.626	22 39 09.4	-09 18 27	20.999	21 15 55.5	-15 59 35	30.814	17 37 06.3	-15 08 39	30.863
Mar	19	07 28 02.7	+22 00 53	8.642	22 39 21.8	-09 17 14	20.994	21 16 02.8	-15 59 03	30.803	17 37 07.6	-15 08 29	30.847
Mar	20	07 28 01.4	+22 01 01	8.657	22 39 34.1	-09 16 02	20.988	21 16 10.0	-15 58 32	30.791	17 37 08.6	-15 08 19	30.830
Mar	21	07 28 00.5	+22 01 08	8.673	22 39 46.4	-09 14 49	20.982	21 16 17.1	-15 58 00	30.780	17 37 09.6	-15 08 10	30.814
Mar	22	07 28 00.1	+22 01 14	8.688	22 39 58.6	-09 13 37	20.976	21 16 24.1	-15 57 29	30.768	17 37 10.4	-15 07 60	30.797
Mar	23	07 28 00.2	+22 01 19	8.704	22 40 10.8	-09 12 26	20.969	21 16 31.0	-15 56 59	30.756	17 37 11.1	-15 07 50	30.781
Mar	24	07 28 00.7	+22 01 24	8.720	22 40 22.8	-09 11 15	20.963	21 16 37.8	-15 56 28	30.744	17 37 11.6	-15 07 40	30.764
Mar	25	07 28 01.7	+22 01 27	8.736	22 40 34.9	-09 10 04	20.956	21 16 44.5	-15 55 59	30.732	17 37 12.0	-15 07 29	30.748
Mar	26	07 28 03.2	+22 01 29	8.752	22 40 46.8	-09 08 53	20.948	21 16 51.2	-15 55 29	30.719	17 37 12.3	-15 07 19	30.732
Mar	27	07 28 05.2	+22 01 30	8.768	22 40 58.7	-09 07 44	20.941	21 16 57.7	-15 55 00	30.707	17 37 12.4	-15 07 09	30.715
Mar	28	07 28 07.6	+22 01 30	8.784	22 41 10.5	-09 06 34	20.933	21 17 04.2	-15 54 32	30.694	17 37 12.4	-15 06 59	30.699
Mar	29	07 28 10.5	+22 01 29	8.800	22 41 22.2	-09 05 25	20.925	21 17 10.5	-15 54 03	30.681	17 37 12.3	-15 06 49	30.683
Mar	30	07 28 13.8	+22 01 27	8.816	22 41 33.8	-09 04 17	20.917	21 17 16.8	-15 53 36	30.667	17 37 12.0	-15 06 39	30.667
Mar	31	07 28 17.7	+22 01 24	8.833	22 41 45.4	-09 03 09	20.908	21 17 23.0	-15 53 08	30.654	17 37 11.6	-15 06 28	30.651
Apr	1	07 28 22.0	+22 01 20	8.849	22 41 56.8	-09 02 01	20.900	21 17 29.0	-15 52 42	30.640	17 37 11.1	-15 06 18	30.635
Apr	2	07 28 26.7	+22 01 15	8.866	22 42 08.2	-09 00 55	20.891	21 17 35.0	-15 52 15	30.626	17 37 10.5	-15 06 08	30.619
Apr	3	07 28 32.0	+22 01 09	8.882	22 42 19.5	-08 59 48	20.882	21 17 40.9	-15 51 49	30.613	17 37 09.7	-15 05 58	30.603
Apr	4	07 28 37.7	+22 01 02	8.899	22 42 30.7	-08 58 42	20.872	21 17 46.6	-15 51 24	30.598	17 37 08.7	-15 05 47	30.588
Apr	5	07 28 43.8	+22 00 54	8.915	22 42 41.8	-08 57 37	20.863	21 17 52.3	-15 50 59	30.584	17 37 07.7	-15 05 37	30.572
Apr	6	07 28 50.4	+22 00 45	8.932	22 42 52.8	-08 56 33	20.853	21 17 57.8	-15 50 34	30.570	17 37 06.5	-15 05 27	30.557
Apr	7	07 28 57.5	+22 00 35	8.948	22 43 03.7	-08 55 29	20.843	21 18 03.2	-15 50 10	30.555	17 37 05.2	-15 05 17	30.541

GEOCENTRIC PLANET POSITIONS (continued)

Note: positions refer to 0000 WAST

MTH	DAY	SATURN			URANUS			NEPTUNE			PLUTO		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Apr	8	07 29 05.0	+22 00 24	8.965	22 43 14.5	-08 54 25	20.833	21 18 08.6	-15 49 47	30.540	17 37 03.7	-15 05 06	30.526
Apr	9	07 29 13.0	+22 00 12	8.982	22 43 25.2	-08 53 22	20.822	21 18 13.8	-15 49 24	30.526	17 37 02.1	-15 04 56	30.511
Apr	10	07 29 21.5	+21 59 59	8.998	22 43 35.8	-08 52 20	20.811	21 18 18.9	-15 49 01	30.511	17 37 00.4	-15 04 46	30.496
Apr	11	07 29 30.3	+21 59 45	9.015	22 43 46.3	-08 51 19	20.800	21 18 23.9	-15 48 39	30.495	17 36 58.6	-15 04 36	30.481
Apr	12	07 29 39.7	+21 59 30	9.032	22 43 56.6	-08 50 18	20.789	21 18 28.8	-15 48 18	30.480	17 36 56.6	-15 04 26	30.466
Apr	13	07 29 49.5	+21 59 14	9.048	22 44 06.9	-08 49 18	20.778	21 18 33.5	-15 47 57	30.465	17 36 54.5	-15 04 16	30.452
Apr	14	07 29 59.7	+21 58 57	9.065	22 44 17.0	-08 48 19	20.766	21 18 38.2	-15 47 36	30.449	17 36 52.3	-15 04 06	30.437
Apr	15	07 30 10.3	+21 58 39	9.081	22 44 27.1	-08 47 20	20.755	21 18 42.7	-15 47 16	30.434	17 36 50.0	-15 03 56	30.423
Apr	16	07 30 21.4	+21 58 20	9.098	22 44 37.0	-08 46 22	20.743	21 18 47.1	-15 46 57	30.418	17 36 47.5	-15 03 46	30.409
Apr	17	07 30 32.9	+21 58 00	9.115	22 44 46.8	-08 45 25	20.731	21 18 51.4	-15 46 38	30.402	17 36 45.0	-15 03 36	30.395
Apr	18	07 30 44.9	+21 57 39	9.131	22 44 56.4	-08 44 28	20.718	21 18 55.6	-15 46 20	30.386	17 36 42.3	-15 03 27	30.381
Apr	19	07 30 57.2	+21 57 17	9.148	22 45 05.9	-08 43 33	20.706	21 18 59.7	-15 46 02	30.370	17 36 39.5	-15 03 17	30.367
Apr	20	07 31 10.0	+21 56 54	9.164	22 45 15.3	-08 42 38	20.693	21 19 03.6	-15 45 45	30.354	17 36 36.5	-15 03 08	30.354
Apr	21	07 31 23.2	+21 56 30	9.180	22 45 24.6	-08 41 44	20.680	21 19 07.4	-15 45 28	30.338	17 36 33.5	-15 02 58	30.340
Apr	22	07 31 36.8	+21 56 05	9.197	22 45 33.8	-08 40 50	20.667	21 19 11.1	-15 45 12	30.322	17 36 30.3	-15 02 49	30.327
Apr	23	07 31 50.8	+21 55 39	9.213	22 45 42.8	-08 39 58	20.654	21 19 14.7	-15 44 57	30.305	17 36 27.1	-15 02 40	30.314
Apr	24	07 32 05.3	+21 55 12	9.229	22 45 51.7	-08 39 06	20.641	21 19 18.1	-15 44 42	30.289	17 36 23.7	-15 02 30	30.301
Apr	25	07 32 20.1	+21 54 45	9.246	22 46 00.4	-08 38 16	20.627	21 19 21.4	-15 44 27	30.272	17 36 20.2	-15 02 21	30.288
Apr	26	07 32 35.3	+21 54 16	9.262	22 46 09.0	-08 37 26	20.613	21 19 24.6	-15 44 14	30.256	17 36 16.6	-15 02 12	30.276
Apr	27	07 32 50.9	+21 53 46	9.278	22 46 17.5	-08 36 36	20.600	21 19 27.7	-15 44 00	30.239	17 36 12.9	-15 02 04	30.264
Apr	28	07 33 06.8	+21 53 15	9.294	22 46 25.8	-08 35 48	20.586	21 19 30.7	-15 43 48	30.223	17 36 09.1	-15 01 55	30.252
Apr	29	07 33 23.2	+21 52 44	9.310	22 46 34.0	-08 35 01	20.571	21 19 33.5	-15 43 36	30.206	17 36 05.2	-15 01 46	30.240
Apr	30	07 33 39.9	+21 52 11	9.326	22 46 42.0	-08 34 14	20.557	21 19 36.2	-15 43 24	30.189	17 36 01.2	-15 01 38	30.228
May	1	07 33 57.1	+21 51 37	9.342	22 46 49.9	-08 33 28	20.543	21 19 38.8	-15 43 13	30.172	17 35 57.1	-15 01 30	30.216
May	2	07 34 14.5	+21 51 03	9.357	22 46 57.7	-08 32 44	20.528	21 19 41.2	-15 43 03	30.156	17 35 52.9	-15 01 21	30.205
May	3	07 34 32.4	+21 50 27	9.373	22 47 05.3	-08 31 60	20.513	21 19 43.5	-15 42 53	30.139	17 35 48.6	-15 01 13	30.194
May	4	07 34 50.6	+21 49 51	9.389	22 47 12.7	-08 31 17	20.499	21 19 45.7	-15 42 44	30.122	17 35 44.2	-15 01 06	30.183
May	5	07 35 09.2	+21 49 13	9.404	22 47 20.0	-08 30 35	20.484	21 19 47.8	-15 42 35	30.105	17 35 39.7	-15 00 58	30.173
May	6	07 35 28.2	+21 48 35	9.419	22 47 27.2	-08 29 54	20.469	21 19 49.7	-15 42 27	30.088	17 35 35.1	-15 00 50	30.162
May	7	07 35 47.4	+21 47 56	9.435	22 47 34.2	-08 29 14	20.453	21 19 51.5	-15 42 20	30.071	17 35 30.4	-15 00 43	30.152
May	8	07 36 07.1	+21 47 16	9.450	22 47 41.0	-08 28 35	20.438	21 19 53.2	-15 42 13	30.054	17 35 25.6	-15 00 36	30.142
May	9	07 36 27.1	+21 46 34	9.465	22 47 47.7	-08 27 56	20.423	21 19 54.7	-15 42 07	30.037	17 35 20.8	-15 00 28	30.132
May	10	07 36 47.4	+21 45 52	9.480	22 47 54.2	-08 27 19	20.407	21 19 56.1	-15 42 02	30.020	17 35 15.9	-15 00 22	30.123
May	11	07 37 08.0	+21 45 09	9.495	22 48 00.5	-08 26 43	20.391	21 19 57.4	-15 41 57	30.003	17 35 10.8	-15 00 15	30.114
May	12	07 37 29.0	+21 44 25	9.509	22 48 06.7	-08 26 08	20.376	21 19 58.5	-15 41 52	29.986	17 35 05.7	-15 00 08	30.105
May	13	07 37 50.3	+21 43 40	9.524	22 48 12.7	-08 25 34	20.360	21 19 59.6	-15 41 49	29.969	17 35 00.5	-15 00 02	30.096
May	14	07 38 12.0	+21 42 54	9.538	22 48 18.6	-08 25 00	20.344	21 20 00.4	-15 41 45	29.952	17 34 55.3	-14 59 56	30.087
May	15	07 38 33.9	+21 42 07	9.553	22 48 24.3	-08 24 28	20.328	21 20 01.2	-15 41 43	29.935	17 34 50.0	-14 59 50	30.079
May	16	07 38 56.1	+21 41 20	9.567	22 48 29.8	-08 23 57	20.312	21 20 01.8	-15 41 41	29.919	17 34 44.6	-14 59 44	30.071
May	17	07 39 18.7	+21 40 31	9.581	22 48 35.2	-08 23 27	20.296	21 20 02.3	-15 41 40	29.902	17 34 39.1	-14 59 38	30.063
May	18	07 39 41.5	+21 39 41	9.595	22 48 40.4	-08 22 58	20.280	21 20 02.7	-15 41 39	29.885	17 34 33.5	-14 59 33	30.056
May	19	07 40 04.7	+21 38 51	9.609	22 48 45.4	-08 22 30	20.263	21 20 02.9	-15 41 39	29.868	17 34 27.9	-14 59 28	30.049
May	20	07 40 28.1	+21 37 60	9.622	22 48 50.2	-08 22 03	20.247	21 20 03.0	-15 41 39	29.852	17 34 22.3	-14 59 23	30.042
May	21	07 40 51.8	+21 37 07	9.636	22 48 54.9	-08 21 37	20.231	21 20 03.0	-15 41 40	29.835	17 34 16.5	-14 59 18	30.035
May	22	07 41 15.8	+21 36 14	9.649	22 48 59.4	-08 21 12	20.214	21 20 02.8	-15 41 42	29.819	17 34 10.8	-14 59 13	30.029
May	23	07 41 40.1	+21 35 20	9.662	22 49 03.7	-08 20 48	20.198	21 20 02.6	-15 41 44	29.802	17 34 04.9	-14 59 09	30.022
May	24	07 42 04.6	+21 34 25	9.675	22 49 07.9	-08 20 26	20.181	21 20 02.2	-15 41 47	29.786	17 33 59.0	-14 59 05	30.017
May	25	07 42 29.4	+21 33 29	9.688	22 49 11.9	-08 20 04	20.164	21 20 01.6	-15 41 50	29.769	17 33 53.1	-14 59 01	30.011
May	26	07 42 54.5	+21 32 33	9.701	22 49 15.7	-08 19 43	20.148	21 20 01.0	-15 41 54	29.753	17 33 47.1	-14 58 57	30.006
May	27	07 43 19.8	+21 31 35	9.714	22 49 19.3	-08 19 24	20.131	21 20 00.2	-15 41 59	29.737	17 33 41.0	-14 58 54	30.000
May	28	07 43 45.4	+21 30 37	9.726	22 49 22.7	-08 19 05	20.115	21 19 59.3	-15 42 04	29.721	17 33 34.9	-14 58 50	29.996
May	29	07 44 11.2	+21 29 37	9.738	22 49 26.0	-08 18 48	20.098	21 19 58.2	-15 42 10	29.705	17 33 28.8	-14 58 47	29.991
May	30	07 44 37.2	+21 28 37	9.750	22 49 29.1	-08 18 32	20.081	21 19 57.1	-15 42 16	29.689	17 33 22.6	-14 58 45	29.987
May	31	07 45 03.5	+21 27 36	9.762	22 49 32.0	-08 18 17	20.064	21 19 55.8	-15 42 23	29.673	17 33 16.4	-14 58 42	29.983
Jun	1	07 45 30.1	+21 26 34	9.774	22 49 34.8	-08 18 03	20.048	21 19 54.4	-15 42 31	29.657	17 33 10.1	-14 58 40	29.979
Jun	2	07 45 56.8	+21 25 32	9.785	22 49 37.3	-08 17 50	20.031	21 19 52.8	-15 42 39	29.642	17 33 03.9	-14 58 38	29.976
Jun	3	07 46 23.8	+21 24 28	9.797	22 49 39.7	-08 17 38	20.014	21 19 51.2	-15 42 47	29.626	17 32 57.5	-14 58 36	29.973
Jun	4	07 46 51.0	+21 23 24	9.808	22 49 41.9	-08 17 27	19.998	21 19 49.4	-15 42 56	29.611	17 32 51.2	-14 58 34	29.970
Jun	5	07 47 18.5	+21 22 18	9.819	22 49 43.9	-08 17 17	19.981	21 19 47.5	-15 43 06	29.596	17 32 44.8	-14 58 33	29.967
Jun	6	07 47 46.1	+21 21 12	9.830	22 49 45.7	-08 17 09	19.964	21 19 45.5	-15 43 16	29.581	17 32 38.4	-14 58 32	29.965
Jun	7	07 48 14.0	+21 20 05	9.840	22 49 47.4	-08 17 01	19.948	21 19 43.3	-15 43 27	29.566	17 32 32.0	-14 58 31	29.963
Jun	8	07 48 42.0	+21 18 58	9.851	22 49 48.9	-08 16 55	19.931	21 19 41.1	-15 43 39	29.551	17 32 25.5	-14 58 31	29.961
Jun	9	07 49 10.3	+21 17 49	9.861	22 49 50.1	-08 16 50	19.914	21 19 38.7	-15 43 51	29.536	17 32 19.1	-14 58 31	29.960
Jun	10	07 49 38.7	+21 16 40	9.871	22 49 51.2	-08 16 45	19.898	21 19 36.2	-15 44 03	29.522	17 32 12.6	-14 58 31	29.959
Jun	11	07 50 07.3	+21 15 30	9.881	22 49 52.1	-08 16 42	19.881	21 19 33.6	-15 44 16	29.507	17 32 06.1	-14 58 31	29.958
Jun	12	07 50 36.2	+21 14 19	9.891	22 49 52.9	-08 16 41	19.865	21 19 30.8	-15 44 30	29.493	17 31 59.6	-14 58 32	29.957
Jun	13	07 51 05.1	+21 13 07	9.900	22 49 53.4	-08 16 40	19.848	21 19 28.0	-15 44 44	29.479	17 31 53.1	-14 58 32	29.957

GEOCENTRIC PLANET POSITIONS (continued)

MTH	DAY	SATURN			URANUS			NEPTUNE			PLUTO		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Jun	14	07 51 34.3	+21 11 55	9.909	22 49 53.8	-08 16 40	19.832	21 19 25.0	-15 44 58	29.465	17 31 46.6	-14 58 33	29.957
Jun	15	07 52 03.6	+21 10 41	9.918	22 49 54.0	-08 16 42	19.815	21 19 22.0	-15 45 13	29.451	17 31 40.1	-14 58 35	29.958
Jun	16	07 52 33.1	+21 09 27	9.927	22 49 54.0	-08 16 44	19.799	21 19 18.8	-15 45 29	29.438	17 31 33.6	-14 58 36	29.958
Jun	17	07 53 02.7	+21 08 13	9.936	22 49 53.8	-08 16 48	19.783	21 19 15.5	-15 45 45	29.424	17 31 27.1	-14 58 38	29.959
Jun	18	07 53 32.5	+21 06 57	9.944	22 49 53.5	-08 16 52	19.767	21 19 12.1	-15 46 01	29.411	17 31 20.6	-14 58 41	29.960
Jun	19	07 54 02.5	+21 05 41	9.952	22 49 52.9	-08 16 58	19.751	21 19 08.6	-15 46 19	29.398	17 31 14.1	-14 58 43	29.962
Jun	20	07 54 32.6	+21 04 24	9.960	22 49 52.2	-08 17 05	19.735	21 19 05.0	-15 46 36	29.385	17 31 07.6	-14 58 46	29.964
Jun	21	07 55 02.8	+21 03 06	9.968	22 49 51.3	-08 17 13	19.719	21 19 01.3	-15 46 54	29.373	17 31 01.2	-14 58 49	29.966
Jun	22	07 55 33.2	+21 01 48	9.976	22 49 50.3	-08 17 22	19.703	21 18 57.5	-15 47 12	29.360	17 30 54.7	-14 58 52	29.968
Jun	23	07 56 03.6	+21 00 29	9.983	22 49 49.0	-08 17 32	19.688	21 18 53.6	-15 47 31	29.348	17 30 48.3	-14 58 56	29.971
Jun	24	07 56 34.3	+20 59 09	9.990	22 49 47.6	-08 17 43	19.672	21 18 49.6	-15 47 51	29.336	17 30 41.9	-14 58 60	29.974
Jun	25	07 57 05.0	+20 57 49	9.997	22 49 46.0	-08 17 55	19.656	21 18 45.5	-15 48 10	29.324	17 30 35.5	-14 59 04	29.977
Jun	26	07 57 35.8	+20 56 27	10.004	22 49 44.2	-08 18 09	19.641	21 18 41.3	-15 48 31	29.312	17 30 29.1	-14 59 08	29.980
Jun	27	07 58 06.8	+20 55 06	10.010	22 49 42.3	-08 18 23	19.626	21 18 37.0	-15 48 51	29.301	17 30 22.8	-14 59 13	29.984
Jun	28	07 58 37.9	+20 53 43	10.017	22 49 40.1	-08 18 38	19.611	21 18 32.6	-15 49 12	29.290	17 30 16.5	-14 59 18	29.988
Jun	29	07 59 09.1	+20 52 20	10.023	22 49 37.8	-08 18 55	19.596	21 18 28.1	-15 49 34	29.279	17 30 10.2	-14 59 23	29.992
Jun	30	07 59 40.4	+20 50 56	10.028	22 49 35.4	-08 19 12	19.581	21 18 23.6	-15 49 55	29.268	17 30 03.9	-14 59 29	29.997
Jul	1	08 00 11.7	+20 49 32	10.034	22 49 32.7	-08 19 31	19.566	21 18 18.9	-15 50 18	29.257	17 29 57.7	-14 59 35	30.002
Jul	2	08 00 43.2	+20 48 07	10.039	22 49 29.9	-08 19 50	19.551	21 18 14.2	-15 50 40	29.247	17 29 51.6	-14 59 41	30.007
Jul	3	08 01 14.8	+20 46 41	10.044	22 49 26.9	-08 20 11	19.537	21 18 09.3	-15 51 03	29.237	17 29 45.4	-14 59 47	30.013
Jul	4	08 01 46.4	+20 45 15	10.049	22 49 23.8	-08 20 32	19.523	21 18 04.4	-15 51 27	29.227	17 29 39.3	-14 59 54	30.018
Jul	5	08 02 18.2	+20 43 48	10.054	22 49 20.4	-08 20 55	19.508	21 17 59.4	-15 51 51	29.217	17 29 33.3	-15 00 01	30.024
Jul	6	08 02 50.0	+20 42 20	10.059	22 49 16.9	-08 21 18	19.494	21 17 54.3	-15 52 15	29.208	17 29 27.3	-15 00 08	30.031
Jul	7	08 03 21.8	+20 40 52	10.063	22 49 13.3	-08 21 43	19.480	21 17 49.2	-15 52 39	29.199	17 29 21.4	-15 00 16	30.037
Jul	8	08 03 53.8	+20 39 24	10.067	22 49 09.5	-08 22 08	19.467	21 17 44.0	-15 53 04	29.190	17 29 15.5	-15 00 24	30.044
Jul	9	08 04 25.8	+20 37 54	10.070	22 49 05.5	-08 22 34	19.453	21 17 38.7	-15 53 29	29.181	17 29 09.6	-15 00 32	30.051
Jul	10	08 04 57.8	+20 36 25	10.074	22 49 01.4	-08 23 02	19.440	21 17 33.3	-15 53 54	29.173	17 29 03.8	-15 00 40	30.058
Jul	11	08 05 29.9	+20 34 54	10.077	22 48 57.1	-08 23 30	19.426	21 17 27.9	-15 54 20	29.165	17 28 58.1	-15 00 49	30.066
Jul	12	08 06 02.0	+20 33 24	10.080	22 48 52.6	-08 23 59	19.413	21 17 22.3	-15 54 46	29.157	17 28 52.5	-15 00 58	30.074
Jul	13	08 06 34.2	+20 31 52	10.083	22 48 48.0	-08 24 29	19.401	21 17 16.8	-15 55 12	29.149	17 28 46.9	-15 01 07	30.082
Jul	14	08 07 06.4	+20 30 21	10.086	22 48 43.2	-08 25 00	19.388	21 17 11.1	-15 55 39	29.142	17 28 41.3	-15 01 17	30.090
Jul	15	08 07 38.7	+20 28 48	10.088	22 48 38.3	-08 25 32	19.375	21 17 05.4	-15 56 06	29.135	17 28 35.9	-15 01 27	30.099
Jul	16	08 08 11.0	+20 27 16	10.090	22 48 33.3	-08 26 05	19.363	21 16 59.7	-15 56 33	29.128	17 28 30.5	-15 01 37	30.108
Jul	17	08 08 43.3	+20 25 43	10.092	22 48 28.1	-08 26 39	19.351	21 16 53.9	-15 57 00	29.121	17 28 25.1	-15 01 48	30.117
Jul	18	08 09 15.6	+20 24 09	10.094	22 48 22.7	-08 27 13	19.339	21 16 48.0	-15 57 28	29.115	17 28 19.9	-15 01 58	30.126
Jul	19	08 09 47.9	+20 22 35	10.095	22 48 17.2	-08 27 48	19.327	21 16 42.1	-15 57 55	29.109	17 28 14.7	-15 02 09	30.136
Jul	20	08 10 20.2	+20 21 01	10.096	22 48 11.6	-08 28 24	19.316	21 16 36.1	-15 58 23	29.103	17 28 09.6	-15 02 21	30.146
Jul	21	08 10 52.6	+20 19 26	10.097	22 48 05.8	-08 29 01	19.305	21 16 30.1	-15 58 52	29.098	17 28 04.6	-15 02 32	30.156
Jul	22	08 11 24.9	+20 17 51	10.098	22 47 59.9	-08 29 39	19.294	21 16 24.0	-15 59 20	29.092	17 27 59.7	-15 02 44	30.166
Jul	23	08 11 57.3	+20 16 15	10.098	22 47 53.9	-08 30 17	19.283	21 16 17.9	-15 59 49	29.088	17 27 54.8	-15 02 56	30.177
Jul	24	08 12 29.6	+20 14 39	10.098	22 47 47.7	-08 30 56	19.272	21 16 11.8	-16 00 17	29.083	17 27 50.1	-15 03 08	30.188
Jul	25	08 13 01.9	+20 13 03	10.098	22 47 41.4	-08 31 36	19.262	21 16 05.6	-16 00 46	29.078	17 27 45.4	-15 03 21	30.199
Jul	26	08 13 34.3	+20 11 27	10.098	22 47 35.0	-08 32 17	19.252	21 15 59.4	-16 01 15	29.074	17 27 40.8	-15 03 34	30.210
Jul	27	08 14 06.6	+20 09 50	10.097	22 47 28.4	-08 32 58	19.242	21 15 53.1	-16 01 44	29.071	17 27 36.3	-15 03 47	30.221
Jul	28	08 14 38.8	+20 08 13	10.097	22 47 21.8	-08 33 40	19.232	21 15 46.8	-16 02 14	29.067	17 27 31.9	-15 04 01	30.233
Jul	29	08 15 11.1	+20 06 35	10.096	22 47 15.0	-08 34 23	19.223	21 15 40.5	-16 02 43	29.064	17 27 27.6	-15 04 14	30.245
Jul	30	08 15 43.3	+20 04 57	10.094	22 47 08.1	-08 35 06	19.213	21 15 34.2	-16 03 13	29.061	17 27 23.3	-15 04 28	30.257
Jul	31	08 16 15.5	+20 03 19	10.093	22 47 01.0	-08 35 50	19.204	21 15 27.8	-16 03 42	29.058	17 27 19.2	-15 04 42	30.269
Aug	1	08 16 47.7	+20 01 41	10.091	22 46 53.9	-08 36 35	19.196	21 15 21.4	-16 04 12	29.056	17 27 15.2	-15 04 57	30.282
Aug	2	08 17 19.8	+20 00 03	10.089	22 46 46.6	-08 37 20	19.187	21 15 15.0	-16 04 42	29.054	17 27 11.2	-15 05 12	30.294
Aug	3	08 17 51.8	+19 58 24	10.087	22 46 39.3	-08 38 06	19.179	21 15 08.5	-16 05 12	29.052	17 27 07.4	-15 05 27	30.307
Aug	4	08 18 23.8	+19 56 45	10.085	22 46 31.8	-08 38 53	19.171	21 15 02.1	-16 05 41	29.050	17 27 03.7	-15 05 42	30.320
Aug	5	08 18 55.8	+19 55 06	10.082	22 46 24.3	-08 39 40	19.163	21 14 55.6	-16 06 11	29.049	17 27 00.1	-15 05 57	30.334
Aug	6	08 19 27.6	+19 53 27	10.079	22 46 16.6	-08 40 27	19.156	21 14 49.2	-16 06 41	29.048	17 26 56.5	-15 06 13	30.347
Aug	7	08 19 59.5	+19 51 48	10.076	22 46 08.9	-08 41 15	19.149	21 14 42.7	-16 07 11	29.048	17 26 53.1	-15 06 29	30.361
Aug	8	08 20 31.2	+19 50 08	10.073	22 46 01.0	-08 42 04	19.142	21 14 36.2	-16 07 41	29.047	17 26 49.8	-15 06 46	30.375
Aug	9	08 21 02.9	+19 48 29	10.069	22 45 53.1	-08 42 53	19.135	21 14 29.7	-16 08 11	29.047	17 26 46.7	-15 07 02	30.389
Aug	10	08 21 34.5	+19 46 49	10.065	22 45 45.1	-08 43 42	19.129	21 14 23.2	-16 08 41	29.048	17 26 43.6	-15 07 19	30.403
Aug	11	08 22 06.0	+19 45 09	10.061	22 45 37.0	-08 44 32	19.123	21 14 16.7	-16 09 11	29.048	17 26 40.6	-15 07 36	30.417
Aug	12	08 22 37.4	+19 43 29	10.057	22 45 28.8	-08 45 23	19.117	21 14 10.2	-16 09 41	29.049	17 26 37.8	-15 07 53	30.431
Aug	13	08 23 08.7	+19 41 50	10.052	22 45 20.6	-08 46 13	19.111	21 14 03.7	-16 10 11	29.050	17 26 35.0	-15 08 10	30.446
Aug	14	08 23 39.9	+19 40 10	10.047	22 45 12.3	-08 47 04	19.106	21 13 57.3	-16 10 41	29.052	17 26 32.4	-15 08 28	30.461
Aug	15	08 24 11.0	+19 38 30	10.042	22 45 03.9	-08 47 56	19.101	21 13 50.8	-16 11 10	29.053	17 26 29.9	-15 08 46	30.476
Aug	16	08 24 42.0	+19 36 51	10.037	22 44 55.4	-08 48 48	19.096	21 13 44.4	-16 11 40	29.055	17 26 27.6	-15 09 04	30.491
Aug	17	08 25 12.9	+19 35 11	10.032	22 44 46.9	-08 49 40	19.092	21 13 38.0	-16 12 10	29.058	17 26 25.3	-15 09 22	30.506
Aug	18	08 25 43.7	+19 33 31	10.026	22 44 38.4	-08 50 32	19.088	21 13 31.5	-16 12 39	29.060	17 26 23.2	-15 09 40	30.521
Aug	19	08 26 14.4	+19 31 52	10.020	22 44 29.8	-08 51 25	19.084	21 13 25.2	-16 13 08	29.063	17 26 21.1	-15 09 59	30.537

GEOCENTRIC PLANET POSITIONS (continued)

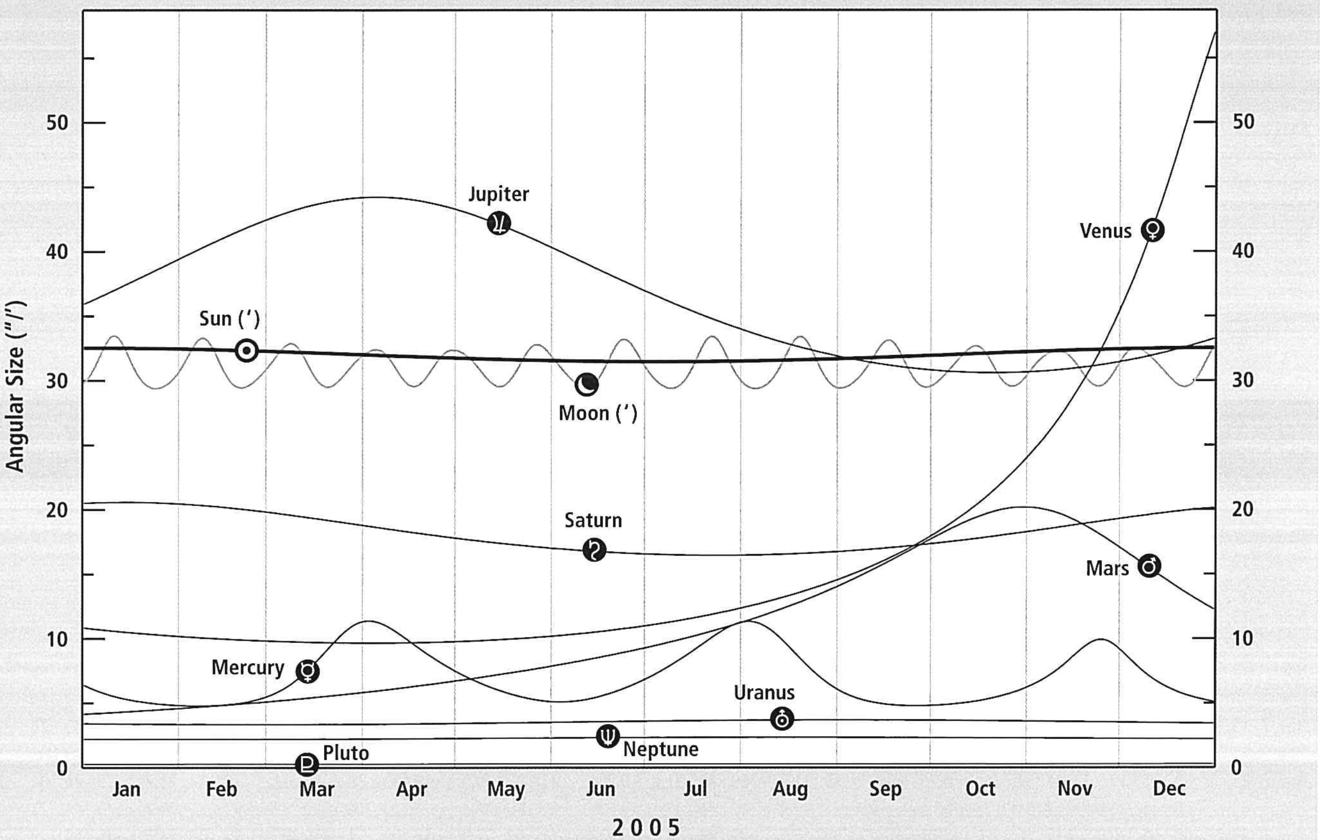
Note: positions refer to 0000 WAST

		SATURN							URANUS							NEPTUNE							PLUTO						
MTH	DAY	RA			Declination			Dist.	RA			Declination			Dist.	RA			Declination			Dist.	RA			Declination			Dist.
		h	m	s	°	′	″	(AU)	h	m	s	°	′	″	(AU)	h	m	s	°	′	″	(AU)	h	m	s	°	′	″	(AU)
Aug	20	08	26	44.9	+19	30	12	10.014	22	44	21.1	-08	52	17	19.080	21	13	18.8	-16	13	37	29.066	17	26	19.2	-15	10	18	30.552
Aug	21	08	27	15.3	+19	28	33	10.008	22	44	12.4	-08	53	10	19.077	21	13	12.5	-16	14	06	29.070	17	26	17.5	-15	10	37	30.568
Aug	22	08	27	45.6	+19	26	54	10.001	22	44	03.6	-08	54	04	19.074	21	13	06.2	-16	14	35	29.074	17	26	15.8	-15	10	56	30.584
Aug	23	08	28	15.7	+19	25	15	9.994	22	43	54.8	-08	54	57	19.071	21	12	59.9	-16	15	04	29.078	17	26	14.3	-15	11	16	30.600
Aug	24	08	28	45.7	+19	23	36	9.987	22	43	46.0	-08	55	51	19.069	21	12	53.7	-16	15	33	29.082	17	26	12.9	-15	11	35	30.616
Aug	25	08	29	15.6	+19	21	58	9.980	22	43	37.1	-08	56	44	19.067	21	12	47.4	-16	16	01	29.087	17	26	11.6	-15	11	55	30.632
Aug	26	08	29	45.3	+19	20	19	9.972	22	43	28.2	-08	57	38	19.065	21	12	41.3	-16	16	29	29.092	17	26	10.5	-15	12	15	30.648
Aug	27	08	30	14.9	+19	18	41	9.965	22	43	19.3	-08	58	32	19.064	21	12	35.1	-16	16	57	29.097	17	26	09.4	-15	12	35	30.665
Aug	28	08	30	44.3	+19	17	03	9.957	22	43	10.4	-08	59	26	19.062	21	12	29.1	-16	17	25	29.102	17	26	08.5	-15	12	56	30.681
Aug	29	08	31	13.6	+19	15	26	9.949	22	43	01.4	-09	00	20	19.061	21	12	23.0	-16	17	52	29.108	17	26	07.8	-15	13	16	30.698
Aug	30	08	31	42.7	+19	13	48	9.940	22	42	52.4	-09	01	14	19.061	21	12	17.0	-16	18	20	29.114	17	26	07.1	-15	13	37	30.714
Aug	31	08	32	11.6	+19	12	11	9.932	22	42	43.4	-09	02	08	19.060	21	12	11.1	-16	18	47	29.120	17	26	06.6	-15	13	58	30.731
Sep	1	08	32	40.3	+19	10	35	9.923	22	42	34.4	-09	03	02	19.060	21	12	05.2	-16	19	14	29.127	17	26	06.2	-15	14	19	30.748
Sep	2	08	33	08.9	+19	08	59	9.914	22	42	25.4	-09	03	57	19.061	21	11	59.4	-16	19	40	29.134	17	26	06.0	-15	14	40	30.765
Sep	3	08	33	37.3	+19	07	23	9.905	22	42	16.4	-09	04	50	19.061	21	11	53.6	-16	20	07	29.141	17	26	05.9	-15	15	01	30.782
Sep	4	08	34	05.5	+19	05	47	9.896	22	42	07.4	-09	05	44	19.062	21	11	47.9	-16	20	33	29.148	17	26	05.9	-15	15	23	30.799
Sep	5	08	34	33.5	+19	04	12	9.886	22	41	58.4	-09	06	38	19.063	21	11	42.2	-16	20	58	29.156	17	26	06.0	-15	15	44	30.816
Sep	6	08	35	01.3	+19	02	38	9.876	22	41	49.4	-09	07	32	19.065	21	11	36.6	-16	21	24	29.164	17	26	06.3	-15	16	06	30.833
Sep	7	08	35	28.9	+19	01	04	9.866	22	41	40.4	-09	08	25	19.067	21	11	31.1	-16	21	49	29.172	17	26	06.7	-15	16	28	30.850
Sep	8	08	35	56.3	+18	59	30	9.856	22	41	31.5	-09	09	19	19.069	21	11	25.6	-16	22	14	29.181	17	26	07.3	-15	16	50	30.867
Sep	9	08	36	23.5	+18	57	57	9.846	22	41	22.6	-09	10	12	19.071	21	11	20.2	-16	22	38	29.189	17	26	08.0	-15	17	12	30.884
Sep	10	08	36	50.4	+18	56	25	9.835	22	41	13.7	-09	11	05	19.074	21	11	14.9	-16	23	03	29.198	17	26	08.8	-15	17	34	30.901
Sep	11	08	37	17.2	+18	54	53	9.824	22	41	04.8	-09	11	57	19.077	21	11	09.7	-16	23	26	29.208	17	26	09.7	-15	17	57	30.919
Sep	12	08	37	43.7	+18	53	22	9.813	22	40	56.0	-09	12	49	19.080	21	11	04.5	-16	23	50	29.217	17	26	10.8	-15	18	19	30.936
Sep	13	08	38	10.0	+18	51	51	9.802	22	40	47.2	-09	13	41	19.083	21	10	59.4	-16	24	13	29.227	17	26	12.0	-15	18	42	30.953
Sep	14	08	38	36.0	+18	50	22	9.791	22	40	38.4	-09	14	33	19.087	21	10	54.4	-16	24	35	29.237	17	26	13.4	-15	19	04	30.970
Sep	15	08	39	01.9	+18	48	52	9.779	22	40	29.7	-09	15	25	19.091	21	10	49.5	-16	24	58	29.247	17	26	14.9	-15	19	27	30.988
Sep	16	08	39	27.4	+18	47	24	9.768	22	40	21.1	-09	16	16	19.096	21	10	44.7	-16	25	20	29.257	17	26	16.5	-15	19	50	31.005
Sep	17	08	39	52.8	+18	45	56	9.756	22	40	12.5	-09	17	06	19.101	21	10	39.9	-16	25	41	29.268	17	26	18.2	-15	20	13	31.022
Sep	18	08	40	17.9	+18	44	29	9.744	22	40	03.9	-09	17	56	19.106	21	10	35.3	-16	26	02	29.279	17	26	20.1	-15	20	36	31.039
Sep	19	08	40	42.7	+18	43	03	9.732	22	39	55.4	-09	18	46	19.111	21	10	30.7	-16	26	23	29.290	17	26	22.1	-15	20	59	31.057
Sep	20	08	41	07.3	+18	41	37	9.719	22	39	47.0	-09	19	36	19.117	21	10	26.2	-16	26	43	29.302	17	26	24.2	-15	21	22	31.074
Sep	21	08	41	31.6	+18	40	13	9.707	22	39	38.6	-09	20	25	19.122	21	10	21.9	-16	27	03	29.313	17	26	26.5	-15	21	45	31.091
Sep	22	08	41	55.6	+18	38	49	9.694	22	39	30.4	-09	21	13	19.129	21	10	17.6	-16	27	23	29.325	17	26	28.9	-15	22	08	31.108
Sep	23	08	42	19.4	+18	37	26	9.681	22	39	22.1	-09	22	01	19.135	21	10	13.4	-16	27	42	29.337	17	26	31.4	-15	22	32	31.125
Sep	24	08	42	42.9	+18	36	03	9.668	22	39	14.0	-09	22	48	19.142	21	10	09.3	-16	28	00	29.349	17	26	34.1	-15	22	55	31.142
Sep	25	08	43	06.2	+18	34	42	9.655	22	39	05.9	-09	23	35	19.149	21	10	05.3	-16	28	18	29.362	17	26	36.9	-15	23	18	31.160
Sep	26	08	43	29.1	+18	33	22	9.642	22	38	58.0	-09	24	22	19.156	21	10	01.4	-16	28	36	29.374	17	26	39.8	-15	23	42	31.177
Sep	27	08	43	51.8	+18	32	03	9.628	22	38	50.1	-09	25	07	19.164	21	09	57.6	-16	28	53	29.387	17	26	42.9	-15	24	05	31.194
Sep	28	08	44	14.2	+18	30	44	9.615	22	38	42.3	-09	25	53	19.171	21	09	53.9	-16	29	10	29.400	17	26	46.0	-15	24	29	31.210
Sep	29	08	44	36.2	+18	29	27	9.601	22	38	34.6	-09	26	37	19.179	21	09	50.4	-16	29	26	29.413	17	26	49.3	-15	24	52	31.227
Sep	30	08	44	58.0	+18	28	10	9.587	22	38	27.0	-09	27	21	19.188	21	09	46.9	-16	29	42	29.427	17	26	52.8	-15	25	16	31.244
Oct	1	08	45	19.5	+18	26	55	9.573	22	38	19.5	-09	28	04	19.196	21	09	43.6	-16	29	57	29.440	17	26	56.3	-15	25	39	31.261
Oct	2	08	45	40.6	+18	25	41	9.559	22	38	12.1	-09	28	47	19.205	21	09	40.3	-16	30	12	29.454	17	27	00.0	-15	26	03	31.277
Oct	3	08	46	01.5	+18	24	28	9.544	22	38	04.8	-09	29	29	19.214	21	09	37.2	-16	30	26	29.468	17	27	03.8	-15	26	27	31.294
Oct	4	08	46	22.0	+18	23	16	9.530	22	37	57.6	-09	30	10	19.224	21	09	34.2	-16	30	40	29.482	17	27	07.8	-15	26	50	31.310
Oct	5	08	46	42.2	+18	22	05	9.515	22	37	50.5	-09	30	51	19.233	21	09	31.3	-16	30	53	29.497	17	27	11.9	-15	27	14	31.327
Oct	6	08	47	02.1	+18	20	55	9.501	22	37	43.6	-09	31	30	19.243	21	09	28.5	-16	31	05	29.511	17	27	16.0	-15	27	37	31.343
Oct	7	08	47	21.6	+18	19	47	9.486	22	37	36.7	-09	32	09	19.254	21	09	25.9	-16	31	18	29.526	17	27	20.4	-15	28	01	31.359
Oct	8	08	47	40.8	+18	18	40	9.471	22	37	30.0	-09	32	48	19.264	21	09	23.3	-16	31	29	29.541	17	27	24.8	-15	28	24	31.375
Oct	9	08	47	59.7	+18	17	34	9.456	22	37	23.4	-09	33	25	19.275	21	09	20.9	-16	31	40	29.556	17	27	29.3	-15	28	48	31.391
Oct	10	08	48	18.2	+18	16	29	9.441	22	37	17.0	-09	34	01	19.285	21	09	18.6	-16	31	51	29.571	17	27	34.0	-15	29	11	31.407
Oct	11	08	48	36.3	+18	15	26	9.425	22	37	10.7	-09	34	37	19.297	21	09	16.4	-16	32	01	29.586	17	27	38.8	-15	29	35	31.423
Oct	12	08	48	54.2	+18	14	24	9.410	22	37	04.5	-09	35	12	19.308	21	09	14.4	-16	32	10	29.601	17	27	43.7	-15	29	58	31.439
Oct	13	08	49	11.6	+18	13	23	9.395	22	36	58.4	-09	35	46	19.319	21	09	12.5	-16	32	19	29.617	17	27	48.8	-15	30	22	31.454
Oct	14	08	49	28.7	+18	12	23	9.379	22	36	52.5	-09	36	19	19.331	21	09	10.7	-16	32	27	29.632	17	27	53.9	-15	30	45	31.469
Oct	15	08	49	45.5	+18	11	25	9.363	22	36	46.8	-09	36	52	19.343	21	09	09.0	-16	32	35	29.648	17	27	59.2	-15	31	08	31.485
Oct	16	08	50	01.8	+18	10	29	9.348	22	36	41.2	-09	37	23	19.355	21	09	07.5	-16	32	42	29.664	17	28	04.5	-15	31	31	31.500
Oct	17	08	50	17.8	+18	09	34	9.332	22	36	35.7	-09	37	53	19.368	21	09	06.1	-16	32	49	29.680	17	28	10.0	-15	31	54	31.515
Oct	18	08	50	33.5	+18	08	40	9.316	22	36	30.4	-09	38	23	19.381	21	09	04.8	-16	32	55	29.696	17	28	15.6	-15	32	17	31.529
Oct	19	08	50	48.7	+18	07	48	9.300	22	36	25.2	-09	38	52	19.393	21	09	03.6	-16	33	00	29.712	17	28	21.3	-15	32	40	31.544
Oct	20	08	51	03.6	+18	06	57	9.284	22	36	20.2	-09	39	19	19.406	21	09	02.6	-16	33	05	29.729	17	28	27.1	-15	33	03	31.559
Oct	21	08	51	18.1	+18	06	07	9.268	22	36	15.3	-09	39	46	19.420	21	09	01.7	-16	33	09	29.745	17	28	33.0	-15	33	26	31.573
Oct	22	08	51	32.2	+18	05	20	9.252	22	36	10.6	-09	40	12	19.433	21	09	01.0	-16	33	13	29.761	17	28	39.0	-15	33	49	31.587
Oct	23	08	51	45.9	+18	04	33	9.236	22	36	06.0	-09	40	37	19.447	21	09	00.3	-16	33	16	29.778	17	28	45.2	-15	34	11	31.601
Oct	24	08	51	59.2	+18	03	49	9.219	22	36	01.7	-09	41	00	19.461	21	08	59.8	-16	33	19	29.795	17	28	51.4	-15	34	34	31.615
Oct	25	08	52	12.2	+18	03	05	9.203	22	35	57.4	-09	41	23	19.475	21	08	59.5	-16	33	21	29.811	17	28	57.7	-15	34	56	31.629

GEOCENTRIC PLANET POSITIONS (continued)

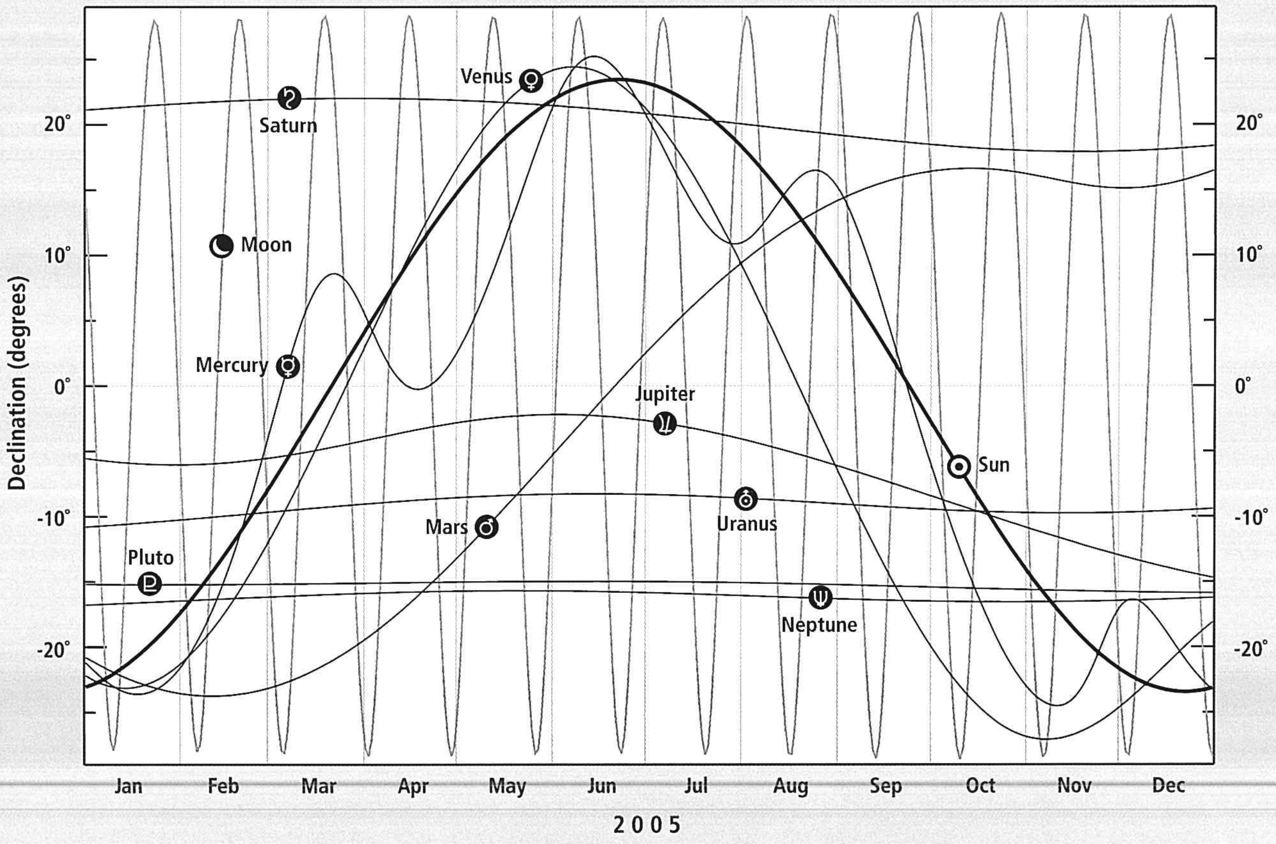
MTH	DAY	SATURN			URANUS			NEPTUNE			PLUTO		
		RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)	RA h m s	Declination ° ′ ″	Dist. (AU)
Oct	26	08 52 24.7	+18 02 24	9.187	22 35 53.4	-09 41 45	19.489	21 08 59.3	-16 33 22	29.828	17 29 04.2	-15 35 18	31.642
Oct	27	08 52 36.8	+18 01 44	9.170	22 35 49.5	-09 42 06	19.503	21 08 59.2	-16 33 23	29.845	17 29 10.7	-15 35 41	31.655
Oct	28	08 52 48.5	+18 01 06	9.154	22 35 45.8	-09 42 25	19.518	21 08 59.2	-16 33 23	29.862	17 29 17.3	-15 36 03	31.668
Oct	29	08 52 59.8	+18 00 29	9.138	22 35 42.2	-09 42 44	19.532	21 08 59.4	-16 33 23	29.879	17 29 24.0	-15 36 25	31.681
Oct	30	08 53 10.7	+17 59 54	9.121	22 35 38.9	-09 43 02	19.547	21 08 59.7	-16 33 22	29.896	17 29 30.9	-15 36 46	31.694
Oct	31	08 53 21.2	+17 59 21	9.105	22 35 35.7	-09 43 18	19.562	21 09 00.1	-16 33 20	29.913	17 29 37.8	-15 37 08	31.707
Nov	1	08 53 31.2	+17 58 49	9.088	22 35 32.6	-09 43 34	19.577	21 09 00.7	-16 33 18	29.930	17 29 44.8	-15 37 30	31.719
Nov	2	08 53 40.8	+17 58 19	9.071	22 35 29.8	-09 43 48	19.592	21 09 01.5	-16 33 15	29.947	17 29 51.9	-15 37 51	31.731
Nov	3	08 53 50.0	+17 57 51	9.055	22 35 27.1	-09 44 02	19.608	21 09 02.3	-16 33 12	29.964	17 29 59.1	-15 38 12	31.743
Nov	4	08 53 58.7	+17 57 25	9.038	22 35 24.7	-09 44 14	19.623	21 09 03.3	-16 33 08	29.982	17 30 06.4	-15 38 33	31.755
Nov	5	08 54 07.1	+17 57 00	9.022	22 35 22.4	-09 44 25	19.639	21 09 04.4	-16 33 03	29.999	17 30 13.7	-15 38 54	31.766
Nov	6	08 54 14.9	+17 56 38	9.005	22 35 20.3	-09 44 35	19.655	21 09 05.7	-16 32 58	30.016	17 30 21.2	-15 39 15	31.777
Nov	7	08 54 22.4	+17 56 17	8.989	22 35 18.3	-09 44 44	19.671	21 09 07.1	-16 32 52	30.033	17 30 28.7	-15 39 36	31.789
Nov	8	08 54 29.4	+17 55 57	8.972	22 35 16.6	-09 44 52	19.687	21 09 08.7	-16 32 46	30.050	17 30 36.3	-15 39 56	31.799
Nov	9	08 54 35.9	+17 55 40	8.956	22 35 15.1	-09 44 59	19.703	21 09 10.3	-16 32 39	30.068	17 30 44.0	-15 40 16	31.810
Nov	10	08 54 42.1	+17 55 24	8.939	22 35 13.7	-09 45 04	19.719	21 09 12.2	-16 32 31	30.085	17 30 51.8	-15 40 36	31.820
Nov	11	08 54 47.7	+17 55 11	8.923	22 35 12.5	-09 45 09	19.736	21 09 14.1	-16 32 23	30.102	17 30 59.6	-15 40 56	31.830
Nov	12	08 54 53.0	+17 54 59	8.906	22 35 11.5	-09 45 12	19.752	21 09 16.2	-16 32 14	30.119	17 31 07.5	-15 41 16	31.840
Nov	13	08 54 57.8	+17 54 49	8.890	22 35 10.7	-09 45 14	19.769	21 09 18.4	-16 32 05	30.136	17 31 15.5	-15 41 36	31.850
Nov	14	08 55 02.1	+17 54 41	8.874	22 35 10.1	-09 45 15	19.785	21 09 20.8	-16 31 55	30.154	17 31 23.5	-15 41 55	31.859
Nov	15	08 55 06.0	+17 54 34	8.857	22 35 09.7	-09 45 15	19.802	21 09 23.2	-16 31 44	30.171	17 31 31.6	-15 42 14	31.869
Nov	16	08 55 09.4	+17 54 30	8.841	22 35 09.5	-09 45 14	19.819	21 09 25.9	-16 31 33	30.188	17 31 39.8	-15 42 33	31.877
Nov	17	08 55 12.4	+17 54 27	8.825	22 35 09.5	-09 45 12	19.836	21 09 28.6	-16 31 21	30.205	17 31 48.1	-15 42 52	31.886
Nov	18	08 55 15.0	+17 54 26	8.809	22 35 09.6	-09 45 08	19.853	21 09 31.5	-16 31 09	30.222	17 31 56.4	-15 43 10	31.894
Nov	19	08 55 17.0	+17 54 27	8.793	22 35 10.0	-09 45 04	19.870	21 09 34.5	-16 30 56	30.239	17 32 04.8	-15 43 28	31.903
Nov	20	08 55 18.7	+17 54 30	8.777	22 35 10.5	-09 44 58	19.887	21 09 37.6	-16 30 42	30.256	17 32 13.2	-15 43 47	31.911
Nov	21	08 55 19.9	+17 54 35	8.761	22 35 11.3	-09 44 51	19.904	21 09 40.9	-16 30 28	30.272	17 32 21.7	-15 44 04	31.918
Nov	22	08 55 20.6	+17 54 42	8.745	22 35 12.2	-09 44 43	19.921	21 09 44.3	-16 30 14	30.289	17 32 30.2	-15 44 22	31.926
Nov	23	08 55 20.9	+17 54 50	8.730	22 35 13.3	-09 44 34	19.938	21 09 47.9	-16 29 59	30.306	17 32 38.8	-15 44 39	31.933
Nov	24	08 55 20.7	+17 55 01	8.714	22 35 14.6	-09 44 23	19.955	21 09 51.5	-16 29 43	30.322	17 32 47.4	-15 44 57	31.940
Nov	25	08 55 20.0	+17 55 13	8.699	22 35 16.2	-09 44 12	19.972	21 09 55.3	-16 29 26	30.339	17 32 56.1	-15 45 14	31.946
Nov	26	08 55 18.9	+17 55 27	8.683	22 35 17.9	-09 43 59	19.990	21 09 59.2	-16 29 10	30.355	17 33 04.9	-15 45 30	31.953
Nov	27	08 55 17.4	+17 55 43	8.668	22 35 19.8	-09 43 46	20.007	21 10 03.3	-16 28 52	30.372	17 33 13.6	-15 45 47	31.959
Nov	28	08 55 15.3	+17 56 01	8.653	22 35 21.9	-09 43 31	20.024	21 10 07.4	-16 28 34	30.388	17 33 22.5	-15 46 03	31.964
Nov	29	08 55 12.9	+17 56 21	8.638	22 35 24.1	-09 43 15	20.041	21 10 11.7	-16 28 16	30.404	17 33 31.3	-15 46 19	31.970
Nov	30	08 55 10.0	+17 56 43	8.623	22 35 26.6	-09 42 58	20.059	21 10 16.1	-16 27 56	30.420	17 33 40.2	-15 46 35	31.975
Dec	1	08 55 06.6	+17 57 06	8.608	22 35 29.3	-09 42 39	20.076	21 10 20.7	-16 27 37	30.436	17 33 49.2	-15 46 50	31.980
Dec	2	08 55 02.7	+17 57 31	8.593	22 35 32.1	-09 42 20	20.093	21 10 25.3	-16 27 17	30.452	17 33 58.2	-15 47 06	31.985
Dec	3	08 54 58.5	+17 57 59	8.579	22 35 35.2	-09 41 59	20.111	21 10 30.1	-16 26 56	30.467	17 34 07.2	-15 47 21	31.989
Dec	4	08 54 53.7	+17 58 28	8.565	22 35 38.4	-09 41 38	20.128	21 10 35.0	-16 26 35	30.483	17 34 16.2	-15 47 35	31.993
Dec	5	08 54 48.6	+17 58 58	8.550	22 35 41.9	-09 41 15	20.145	21 10 40.0	-16 26 13	30.498	17 34 25.3	-15 47 50	31.997
Dec	6	08 54 43.0	+17 59 31	8.536	22 35 45.5	-09 40 51	20.162	21 10 45.1	-16 25 50	30.513	17 34 34.4	-15 48 04	32.001
Dec	7	08 54 36.9	+18 00 05	8.522	22 35 49.3	-09 40 26	20.179	21 10 50.4	-16 25 28	30.529	17 34 43.5	-15 48 18	32.004
Dec	8	08 54 30.4	+18 00 42	8.509	22 35 53.3	-09 39 60	20.197	21 10 55.8	-16 25 04	30.543	17 34 52.6	-15 48 32	32.007
Dec	9	08 54 23.5	+18 01 19	8.495	22 35 57.5	-09 39 32	20.214	21 11 01.2	-16 24 40	30.558	17 35 01.8	-15 48 45	32.010
Dec	10	08 54 16.1	+18 01 59	8.482	22 36 01.9	-09 39 04	20.231	21 11 06.8	-16 24 16	30.573	17 35 10.9	-15 48 59	32.012
Dec	11	08 54 08.4	+18 02 40	8.469	22 36 06.5	-09 38 35	20.248	21 11 12.5	-16 23 51	30.587	17 35 20.1	-15 49 11	32.014
Dec	12	08 54 00.2	+18 03 23	8.456	22 36 11.2	-09 38 04	20.265	21 11 18.3	-16 23 26	30.602	17 35 29.3	-15 49 24	32.016
Dec	13	08 53 51.6	+18 04 08	8.443	22 36 16.1	-09 37 33	20.281	21 11 24.2	-16 22 60	30.616	17 35 38.5	-15 49 36	32.017
Dec	14	08 53 42.5	+18 04 54	8.430	22 36 21.2	-09 36 60	20.298	21 11 30.2	-16 22 34	30.630	17 35 47.7	-15 49 48	32.019
Dec	15	08 53 33.1	+18 05 42	8.418	22 36 26.5	-09 36 26	20.315	21 11 36.3	-16 22 07	30.644	17 35 57.0	-15 50 00	32.020
Dec	16	08 53 23.3	+18 06 31	8.406	22 36 32.0	-09 35 52	20.332	21 11 42.6	-16 21 40	30.657	17 36 06.2	-15 50 12	32.020
Dec	17	08 53 13.0	+18 07 22	8.394	22 36 37.6	-09 35 16	20.348	21 11 48.9	-16 21 12	30.671	17 36 15.4	-15 50 23	32.021
Dec	18	08 53 02.4	+18 08 14	8.382	22 36 43.4	-09 34 39	20.365	21 11 55.3	-16 20 44	30.684	17 36 24.6	-15 50 34	32.021
Dec	19	08 52 51.4	+18 09 08	8.370	22 36 49.4	-09 34 01	20.381	21 12 01.8	-16 20 15	30.697	17 36 33.9	-15 50 45	32.021
Dec	20	08 52 40.0	+18 10 03	8.359	22 36 55.5	-09 33 23	20.397	21 12 08.4	-16 19 46	30.710	17 36 43.1	-15 50 55	32.020
Dec	21	08 52 28.2	+18 11 00	8.348	22 37 01.9	-09 32 43	20.413	21 12 15.1	-16 19 17	30.723	17 36 52.3	-15 51 05	32.019
Dec	22	08 52 16.0	+18 11 59	8.337	22 37 08.4	-09 32 02	20.429	21 12 21.9	-16 18 47	30.735	17 37 01.5	-15 51 15	32.018
Dec	23	08 52 03.5	+18 12 58	8.326	22 37 15.0	-09 31 20	20.445	21 12 28.8	-16 18 17	30.748	17 37 10.7	-15 51 25	32.017
Dec	24	08 51 50.6	+18 13 59	8.316	22 37 21.9	-09 30 37	20.461	21 12 35.8	-16 17 46	30.760	17 37 19.9	-15 51 34	32.015
Dec	25	08 51 37.4	+18 15 01	8.306	22 37 28.9	-09 29 54	20.477	21 12 42.9	-16 17 15	30.772	17 37 29.1	-15 51 43	32.013
Dec	26	08 51 23.8	+18 16 05	8.296	22 37 36.0	-09 29 09	20.492	21 12 50.0	-16 16 43	30.783	17 37 38.2	-15 51 51	32.011
Dec	27	08 51 09.8	+18 17 10	8.286	22 37 43.4	-09 28 23	20.508	21 12 57.3	-16 16 11	30.795	17 37 47.4	-15 51 60	32.009
Dec	28	08 50 55.5	+18 18 16	8.277	22 37 50.9	-09 27 37	20.523	21 13 04.6	-16 15 39	30.806	17 37 56.5	-15 52 08	32.006
Dec	29	08 50 40.9	+18 19 23	8.267	22 37 58.5	-09 26 49	20.538	21 13 12.0	-16 15 06	30.817	17 38 05.6	-15 52 16	32.003
Dec	30	08 50 26.0	+18 20 32	8.259	22 38 06.3	-09 26 01	20.553	21 13 19.5	-16 14 33	30.828	17 38 14.6	-15 52 23	31.999
Dec	31	08 50 10.8	+18 21 41	8.250	22 38 14.3	-09 25 11	20.568	21 13 27.1	-16 13 60	30.838	17 38 23.7	-15 52 30	31.996

ANGULAR SIZES OF THE PLANETS 2005

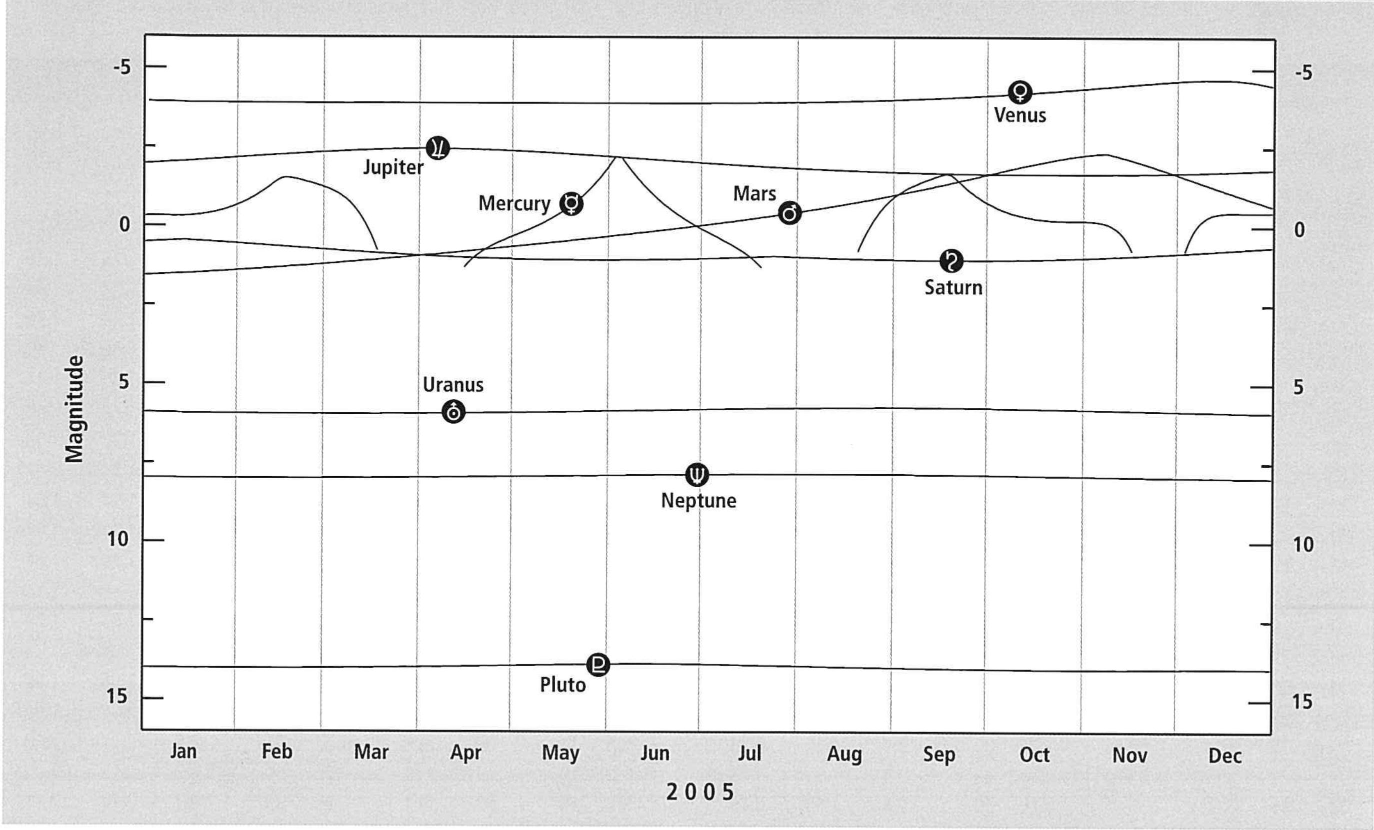


Note: Size of Sun and Moon in arc minutes.

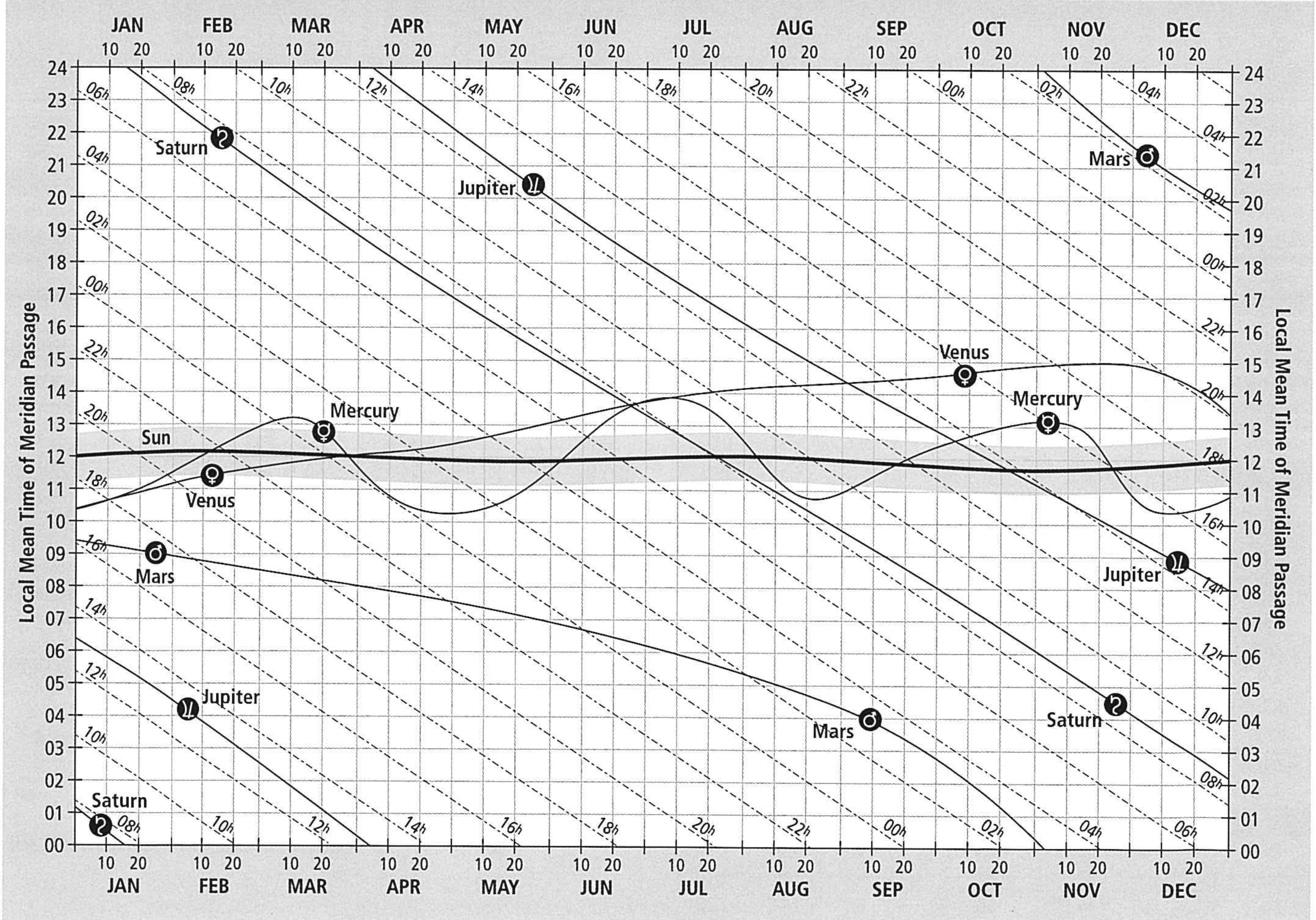
DECLINATIONS OF THE PLANETS 2005



MAGNITUDES OF THE PLANETS 2005



MERIDIAN TRANSIT OF PLANETS 2005



Geocentric positions of comets

Ephemerides are provided for known comets with V brighter than 10 and Declination less than +30°. Please note that comet brightness is notoriously unpredictable!

GEOCENTRIC POSITIONS OF COMETS 2005 Note: positions refer to 0000 WAST

DATE		RA		DECLINATION		V	r	Δ
Mnth	Day	h	m	°	′		(AU)	(AU)
9P/Tempel 1								
Apr	23	13	03.5	+12	35	10.0	1.67	0.72
Apr	25	13	01.9	+12	23	9.9	1.67	0.72
Apr	27	13	00.4	+12	09	9.9	1.66	0.72
Apr	29	12	58.9	+11	52	9.8	1.65	0.71
May	1	12	57.6	+11	34	9.8	1.64	0.71
May	3	12	56.4	+11	14	9.7	1.63	0.71
May	5	12	55.3	+10	52	9.7	1.63	0.71
May	7	12	54.4	+10	28	9.7	1.62	0.71
May	9	12	53.6	+10	02	9.6	1.61	0.71
May	11	12	52.9	+09	34	9.6	1.61	0.71
May	13	12	52.4	+09	05	9.6	1.60	0.72
May	15	12	52.0	+08	34	9.5	1.59	0.72
May	17	12	51.9	+08	02	9.5	1.59	0.72
May	19	12	51.9	+07	28	9.5	1.58	0.73
May	21	12	52.0	+06	53	9.5	1.57	0.73
May	23	12	52.4	+06	17	9.4	1.57	0.73
May	25	12	52.9	+05	39	9.4	1.56	0.74
May	27	12	53.6	+05	00	9.4	1.56	0.74
May	29	12	54.5	+04	20	9.4	1.55	0.75
May	31	12	55.5	+03	39	9.4	1.55	0.75
Jun	1	12	56.1	+03	19	9.4	1.55	0.76
Jun	3	12	57.3	+02	36	9.4	1.54	0.76
Jun	5	12	58.8	+01	53	9.4	1.54	0.77
Jun	7	13	00.4	+01	10	9.4	1.53	0.78
Jun	9	13	02.2	+00	25	9.3	1.53	0.78
Jun	11	13	04.1	-00	20	9.3	1.53	0.79
Jun	13	13	06.2	-01	05	9.4	1.52	0.80
Jun	15	13	08.5	-01	51	9.4	1.52	0.80
Jun	17	13	10.9	-02	38	9.4	1.52	0.81
Jun	19	13	13.4	-03	25	9.4	1.52	0.82
Jun	21	13	16.1	-04	12	9.4	1.51	0.83
Jun	23	13	18.9	-04	59	9.4	1.51	0.84
Jun	25	13	21.9	-05	46	9.4	1.51	0.85
Jun	27	13	25.0	-06	34	9.4	1.51	0.86
Jun	29	13	28.2	-07	21	9.4	1.51	0.87
Jul	1	13	31.6	-08	09	9.5	1.51	0.88
Jul	3	13	35.0	-08	56	9.5	1.51	0.89
Jul	5	13	38.6	-09	44	9.5	1.51	0.90
Jul	7	13	42.3	-10	31	9.5	1.51	0.91
Jul	9	13	46.1	-11	18	9.6	1.51	0.92
Jul	11	13	50.1	-12	04	9.6	1.51	0.93
Jul	13	13	54.1	-12	51	9.6	1.51	0.94
Jul	15	13	58.3	-13	37	9.7	1.51	0.95
Jul	17	14	02.6	-14	22	9.7	1.51	0.96
Jul	19	14	06.9	-15	07	9.7	1.51	0.98
Jul	21	14	11.4	-15	52	9.8	1.51	0.99
Jul	23	14	15.9	-16	35	9.8	1.52	1.00
Jul	25	14	20.6	-17	19	9.8	1.52	1.02
Jul	27	14	25.3	-18	01	9.9	1.52	1.03
Jul	29	14	30.2	-18	43	9.9	1.52	1.04
Jul	31	14	35.1	-19	24	10.0	1.53	1.06
C/2003 K4 (LINEAR)								
Jan	1	06	32.3	-59	10	6.1	1.64	1.18
Jan	3	06	09.3	-58	01	6.2	1.66	1.20
Jan	5	05	48.5	-56	38	6.2	1.68	1.22
Jan	7	05	30.0	-55	04	6.3	1.71	1.24
Jan	9	05	13.7	-53	21	6.4	1.73	1.27
Jan	11	04	59.5	-51	34	6.5	1.75	1.30
Jan	13	04	47.2	-49	45	6.6	1.78	1.33
Jan	15	04	36.5	-47	54	6.7	1.80	1.36
Jan	17	04	27.2	-46	05	6.8	1.82	1.40
Jan	19	04	19.1	-44	17	6.9	1.85	1.44
Jan	21	04	12.1	-42	32	7.0	1.87	1.48
Jan	23	04	06.1	-40	50	7.1	1.90	1.53
Jan	25	04	00.8	-39	11	7.3	1.92	1.57
Jan	27	03	56.1	-37	36	7.4	1.94	1.62
Jan	29	03	52.1	-36	05	7.5	1.97	1.67
Jan	31	03	48.7	-34	38	7.6	1.99	1.71
Feb	1	03	47.1	-33	56	7.6	2.00	1.74
Feb	3	03	44.3	-32	35	7.7	2.03	1.79
Feb	5	03	41.8	-31	17	7.8	2.05	1.84
Feb	7	03	39.7	-30	03	7.9	2.08	1.89
Feb	9	03	38.0	-28	52	8.0	2.10	1.95
Feb	11	03	36.4	-27	45	8.1	2.12	2.00
Feb	13	03	35.2	-26	40	8.2	2.15	2.05
Feb	15	03	34.1	-25	39	8.3	2.17	2.11
Feb	17	03	33.2	-24	40	8.4	2.20	2.16
Feb	19	03	32.5	-23	44	8.5	2.22	2.22
Feb	21	03	32.0	-22	50	8.6	2.24	2.27
Feb	23	03	31.6	-21	59	8.7	2.27	2.33
Feb	25	03	31.3	-21	10	8.8	2.29	2.38
Feb	27	03	31.2	-20	23	8.9	2.32	2.44
Mar	1	03	31.2	-19	38	8.9	2.34	2.49
Mar	3	03	31.3	-18	55	9.0	2.36	2.55
Mar	5	03	31.4	-18	14	9.1	2.39	2.60
Mar	7	03	31.7	-17	34	9.2	2.41	2.65
Mar	9	03	32.0	-16	56	9.3	2.44	2.71
Mar	11	03	32.4	-16	20	9.3	2.46	2.76
Mar	13	03	32.9	-15	45	9.4	2.48	2.81
Mar	15	03	33.4	-15	11	9.5	2.51	2.86
Mar	17	03	34.0	-14	39	9.6	2.53	2.92
Mar	19	03	34.6	-14	08	9.6	2.55	2.97
Mar	21	03	35.3	-13	38	9.7	2.58	3.02
Mar	23	03	36.0	-13	09	9.8	2.60	3.07
Mar	25	03	36.8	-12	42	9.8	2.62	3.12
Mar	27	03	37.6	-12	15	9.9	2.65	3.16
Mar	29	03	38.5	-11	50	10.0	2.67	3.21
Mar	30	03	38.9	-11	37	10.0	2.68	3.24

Legend:

RA and DECLINATION	Astrometric right ascension and declination of target (J2000.0). Corrected for light-time. These positions refer to the geocentre. However, none of these comets get very close to Earth and the effects of parallax are less than the quoted level of precision.
V	Comet's approximate apparent visual total magnitude
r	Apparent heliocentric range (distance between comet and Sun)
Δ	Apparent range (distance between comet and Earth

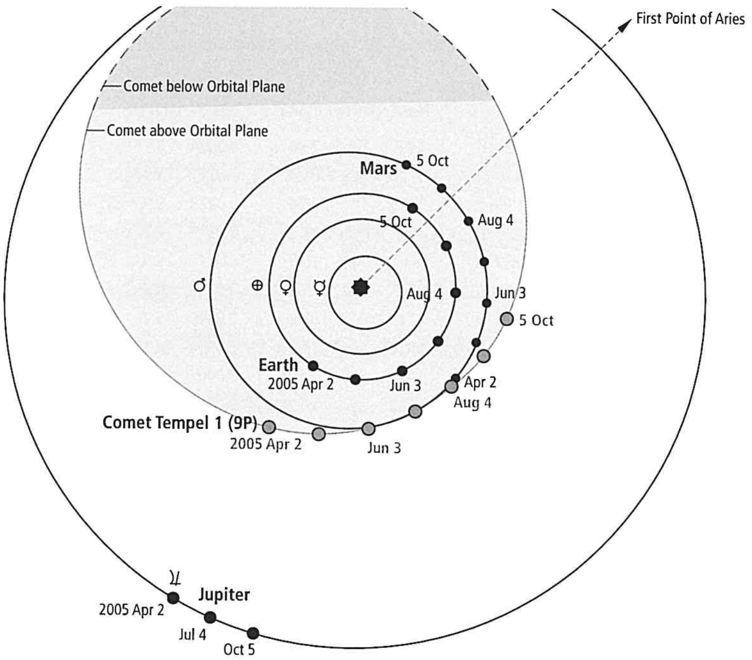
Comet Tempel 1 (9P) and the Deep Impact Mission

Comet Tempel 1 (9P) is the target for the Deep Impact Mission – the first to explore a comet's interior by using a spacecraft to create a crater thus allowing us to look deep inside.

Dramatic images from both the flyby spacecraft and the impactor will be sent back to Earth as data in near-realtime.

These first-ever views deep beneath a comet's surface, and additional scientific measurements, will provide clues to the formation of the Solar System.

Amateur astronomers will combine efforts with astronomers at larger telescopes to offer the public an earth-based look at this incredible July 2005 encounter with a comet.



FUTURE KNOWN CLOSEST ENCOUNTERS

DESIGNATION		DATE			DISTANCE	
Permanent	Provisional	Year	Month	Day (UT)	(AU)	(LD)
EXPECTED CLOSE ENCOUNTERS 2005 (time order)						
	2002 FW1	2005	Mar	10.48	0.02977	11.58
	2003 YN107	2005	Jun	23.17	0.02999	11.67
	2000 AG6	2005	Jul	22.90	0.02268	8.82
54509	2000 PH5	2005	Jul	26.69	0.03588	13.96
	1992 UY4	2005	Aug	08.38	0.04038	15.71
	1999 RQ36	2005	Sep	20.45	0.03313	12.89
	2000 UK11	2005	Nov	03.04	0.03276	12.75
EXPECTED CLOSE ENCOUNTERS 2006 (time order)						
23187		2006	Mar	06.18	0.02034	7.91
	2001 FO127	2006	Mar	22.10	0.02874	11.18
	2004 DC	2006	Jun	03.81	0.02603	10.13
	2003 YN107	2006	Jun	10.43	0.02230	8.68
	2002 TZ57	2006	Sep	26.88	0.04637	18.04
	2001 CB21	2006	Oct	02.45	0.04787	18.63
	2001 UP	2006	Oct	22.05	0.03148	12.25
	2001 WV1	2006	Nov	21.54	0.03670	14.28
TWENTY FUTURE KNOWN CLOSEST ENCOUNTERS (ranked by distance)						
	2001 WN5	2028	Jun	26.23	0.001670	0.65
	2003 MK4	2110	Jan	04.41	0.001813	0.71
	1998 OX4	2148	Jan	22.14	0.002003	0.78
	2000 WO107	2140	Dec	01.82	0.002146	0.84
	1999 AN10	2027	Aug	07.29	0.002652	1.03
35396		2136	Oct	28.49	0.002762	1.07
	1998 MZ	2116	Nov	27.00	0.002917	1.14
	2003 QC10	2066	Sep	24.86	0.003396	1.32
	1999 RQ36	2080	Sep	23.21	0.003582	1.39
	2002 SZ	2067	Sep	10.49	0.003687	1.43
	2001 GQ2	2100	Apr	27.68	0.003976	1.55
	2002 CU11	2080	Aug	31.02	0.004194	1.63
	2004 HD2	2093	Apr	08.62	0.004880	1.90
	1999 RQ36	2060	Sep	23.02	0.005032	1.96
	2003 MK4	2032	Jan	03.96	0.005074	1.97
	2002 NN4	2130	Jun	07.78	0.005156	2.01
	2002 AW	2103	Oct	06.90	0.005167	2.01
	1999 MN	2137	Jun	04.26	0.005462	2.13
	1999 RQ36	2158	Sep	25.47	0.005509	2.14
	1994 WR12	2080	Nov	23.61	0.005639	2.19

CLOSE APPROACHES BY HISTORIC COMETS

COMET NAME	Designation	DATE			DISTANCE	
		Year	Mnth	Day	(AU)	(LD)
Comet of 1491	C/1491 B1	1491	Feb	20.0	0.0094	3.7*
Lexell	D/1770 L1	1770	Jul	01.7	0.0151	5.9
Tempel-Tuttle	55P/1366 U1	1366	Oct	26.4	0.0229	8.9
IRAS-Araki-Alcock	C/1983 H1	1983	May	11.5	0.0313	12.2
Halley	1P/ 837 F1	837	Apr	10.5	0.0334	13.0
Biela	3D/1805 V1	1805	Dec	09.9	0.0366	14.2
Comet of 1743	C/1743 C1	1743	Feb	08.9	0.0390	15.2
Pons-Winnecke	7P	1927	Jun	26.8	0.0394	15.3
Comet of 1014	C/1014 C1	1014	Feb	24.9	0.0407	15.8*
Comet of 1702	C/1702 H1	1702	Apr	20.2	0.0437	17.0
Comet of 1132	C/1132 T1	1132	Oct	07.2	0.0447	17.4*
Comet of 1351	C/1351 W1	1351	Nov	29.4	0.0479	18.6*
Comet of 1345	C/1345 O1	1345	Jul	31.9	0.0485	18.9*
Comet of 1499	C/1499 Q1	1499	Aug	17.1	0.0588	22.9*
Schwassmann-Wachmann 3	73P/1930 J1	1930	May	31.7	0.0617	24.0
Sugano-Saigusa-Fujikawa	C/1983 J1	1983	Jun	12.8	0.0628	24.4
Comet of 1080	C/1080 P1	1080	Aug	05.7	0.0641	24.9*
Great comet	C/1760 A1	1760	Jan	08.2	0.0681	26.5
Comet of 1472	C/1471 Y1	1472	Jan	22.9	0.0690	26.9*
Comet of 400	C/ 400 F1	400	Mar	31.1	0.0767	29.8*
LINEAR	P/2000 G1	1921	Mar	09.9	0.0775	30.1
Comet of 1556	C/1556 D1	1556	Mar	13.0	0.0835	32.5*
Schweizer	C/1853 G1	1853	Apr	29.1	0.0839	32.7
Bouvard-Herschel	C/1797 P1	1797	Aug	16.5	0.0879	34.2
Halley	1P/ 374 E1	374	Apr	01.9	0.0884	34.4
Halley	1P/ 607 H1	607	Apr	19.2	0.0898	34.9
Comet of 568	C/ 568 O1	568	Sep	25.7	0.0918	35.7*
Messier	C/1763 S1	1763	Sep	23.7	0.0934	36.3
Tempel	C/1864 N1	1864	Aug	08.4	0.0964	37.5
Machholz 2	141P	1905	Jan	05.2	0.0968	37.7
LINEAR	P/2000 G1	2000	Mar	04.7	0.0974	37.9
Schmidt	C/1862 N1	1862	Jul	04.6	0.0982	38.2
Comet of 390	C/ 390 Q1	390	Aug	18.9	0.1002	39.0*
Hyakutake	C/1996 B2	1996	Mar	25.3	0.1018	39.6
Seki	C/1961 T1	1961	Nov	15.2	0.1019	39.7

Notes:

* Distance is uncertain because comet's orbit is relatively poorly determined.

CLOSE APPROACHES BY ASTEROIDS

DISTANCE		DATE (TT)			DESIGNATION **(Permanent)** Provisional
(AU)	(LD)	Year	Mnth	Day	
0.000086*	0.03	2004	Mar	31.65	2004 FU162
0.00033	0.13	2004	Mar	18.92	2004 FH
0.00056	0.22	2003	Sep	27.96	2003 SQ222
0.00072	0.28	1994	Dec	09.79	1994 XM1
0.00079	0.31	2002	Dec	11.35	2002 XV90
0.00080	0.31	2002	Jun	14.09	2002 MN
0.00099	0.39	1993	May	20.86	1993 KA2
0.00099	0.39	2003	Dec	06.79	2003 XJ7
0.00108	0.42	2003	Sep	19.24	2003 SW130
0.00111	0.43	2004	Jul	16.21	2004 OD4
0.00113	0.44	1994	Mar	15.72	1994 ES1
0.00114	0.44	1991	Jan	18.72	1991 BA
0.00160	0.62	2004	Mar	27.85	2004 FY15
0.00185	0.72	2004	Apr	18.01	2004 HE
0.00188	0.73	2003	Oct	12.07	2003 UM3
0.00205++	0.80	2001	Jan	15.85	2001 BA16
0.00221	0.86	2003	Apr	29.27	2003 HW10
0.00282	1.10	2002	Mar	31.15	2002 GQ
0.00289+	1.12	1995	Mar	27.15	1995 FF
0.00303	1.18	1996	May	19.69	1996 JA1
0.00306	1.19	2003	Dec	06.95	2003 XV
0.00306**	1.19	1991	Dec	05.39	1991 VG
0.00311	1.21	2002	Mar	08.04	2002 EM7
0.00321	1.25	2002	Feb	08.80	2002 CB26
0.00326	1.27	2004	Feb	24.30	2004 DA53
0.00331	1.29	2003	June	01.22	2003 LW2
0.00332	1.29	2000	June	02.90	2000 LG6
0.00352	1.37	2002	Aug	18.33	2002 NY40
0.00362	1.41	2003	Mar	03.26	2003 DW10
0.00367	1.43	2003	Mar	05.85	2003 DY15
0.00378	1.47	2004	June	21.86	2004 MR1
0.00380	1.48	1999	May	06.14	2000 SG344
0.00411	1.60	2004	Aug	11.84	2004 PZ19
0.00423	1.65	2003	Dec	27.00	2003 YS70
0.00445	1.73	2004	Feb	01.99	2004 BK86
0.00454	1.77	2003	Nov	30.80	2003 WT153
0.00457	1.78	1989	Mar	22.90	**(4581) Asclepius** 1989 FC
0.00464	1.81	2004	Mar	25.79	2004 FM32
0.00466	1.81	2004	May	31.88	2004 KF17
0.00474	1.84	1994	Nov	24.85	1994 WR12
0.00484	1.88	2001	Nov	29.33	2001 WM15
0.00495	1.93	2000	Dec	22.29	2000 YA
0.00495	1.93	1937	Oct	30.71	**(69230) Hermes** 1937 UB
0.00500	1.95	1995	Oct	17.20	1995 UB
0.00510	1.98	2002	Oct	02.08	2002 TY59
0.00526	2.05	2003	Aug	27.39	2003 QB30
0.00528	2.05	2001	Nov	20.86	2001 WJ4
0.00529	2.06	2002	Oct	01.25	2002 TX55
0.00531	2.07	2004	Mar	17.32	2004 FY3
0.00536	2.09	2004	Aug	15.31	2004 PU42
0.00539	2.10	1998	June	08.24	1998 KY26
0.00557	2.17	2002	Jan	07.32	2001 YB5
0.00595	2.32	2001	Feb	23.06	2001 DZ76
0.00628	2.44	2001	Oct	21.36	2001 UP
0.00643	2.50	2001	Oct	08.65	2001 TB
0.00656	2.55	2002	Feb	05.47	2002 CA26
0.00664	2.58	2002	Oct	05.50	2002 TZ66
0.00670	2.61	1993	Oct	18.80	1993 UA
0.00679	2.64	1999	Feb	04.08	1999 CQ2
0.00690	2.68	1994	Apr	12.10	1994 GV
0.00700	2.72	2004	Apr	26.24	2004 HT59
0.00709	2.76	2003	Sep	27.19	2003 SR84
0.00710	2.76	1993	May	17.90	1993 KA
0.00710	2.76	1997	Oct	26.20	1997 UA11
0.00728	2.83	2004	Feb	17.04	2004 DF2
0.00736	2.86	1997	Feb	09.78	1997 CD17
0.00740	2.88	2003	Oct	27.30	2003 UT55
0.00775	3.02	1976	Oct	20.70	**(2340) Hathor** 1976 UA
0.00777	3.02	2004	May	18.01	2004 JP1
0.00792	3.08	2003	Sep	16.67	2003 SL36
0.00801	3.12	2003	Dec	30.10	2003 YH111
0.00802	3.12	2004	Mar	20.07	2004 FY1
0.00814	3.17	2004	May	17.53	2004 JO20
0.00822	3.20	2002	Apr	06.16	2002 FD6
0.00872	3.39	2003	Apr	03.76	2003 GG21
0.00879	3.42	1999	Mar	12.86	1999 FR5
0.00892	3.47	2001	Dec	15.15	2001 YN2
0.00898	3.49	2001	Aug	15.48	2001 QE71
0.00904	3.52	2000	Dec	29.35	2001 AV43
0.00909	3.54	2003	Sep	30.70	2003 SM215
0.00930	3.62	2003	June	20.27	2003 ME1
0.00931	3.62	2003	Mar	22.36	2003 FY6
0.00932	3.63	2003	Apr	27.75	2003 JX2
0.00939	3.65	2004	June	29.51	2004 MC
0.00947	3.68	2003	Sep	17.01	2003 RU11
0.00966	3.76	2004	Feb	01.80	2004 CA2
0.00983	3.82	2001	Feb	26.72	2001 EC
0.00984	3.83	1988	Sep	29.09	1988 TA
0.00990	3.85	2004	Jan	18.18	2004 BN41
0.00999	3.89	2003	May	28.29	2003 LH

Notes:

* This approach is to about 11,500 km!

** 1991 VG may be a returning piece of man-made space debris.

\+ Closest approach to the Moon was 0.0013 AU on 1995 Mar. 27.0.

++ Closest approach to the Moon was 0.00053 AU on 2001 Jan. 15.80.

AU Astronomical distance Unit: 1.0 AU is roughly the average distance between the Earth and the Sun (= 149,597,870 km).

LD Lunar Distance unit: 1.0 LD is the average distance from the Earth to the Moon (about 0.00257 AU = 384,400 km).

Near-Earth Objects

Near-earth objects (NEOs) are comets and asteroids that have been nudged by the gravitational attraction of nearby planets into orbits that allow them to enter the Earth's neighbourhood. Composed mostly of water ice with embedded dust particles, comets originally formed in the cold outer planetary system while most of the rocky asteroids formed in the warmer inner solar system between the orbits of Mars and Jupiter. The scientific interest in comets and asteroids is due largely to their status as the relatively unchanged remnant debris from the solar system formation process some 4.6 billion years ago. The giant outer planets (Jupiter, Saturn, Uranus, and Neptune) formed from an agglomeration of billions of comets and the left over bits and pieces from this formation process are the comets we see today. Likewise, today's asteroids are the bits and pieces left over from the initial agglomeration of the inner planets that include Mercury, Venus, Earth, and Mars. As the primitive, leftover building blocks of the solar system formation process, comets and asteroids offer clues to the chemical mixture from which the planets formed some 4.6 billion years ago. If we wish to know the composition of the primordial mixture from which the planets formed, then we must determine the chemical constituents of the leftover debris from this formation process – the comets and asteroids.

NEO GROUPS

Group Description Definition:	
NECs	Near-Earth Comets. $q<1.3$ AU, $P<200$ yrs
NEAs	Near-Earth Asteroids. $q<1.3$ AU
Atens	Earth-crossing NEAs with semi-major axes smaller than Earth's (named after asteroid 2062 Aten). $a<1.0$ AU, $Q>0.983$ AU
Apollos	Earth-crossing NEAs with semi-major axes larger than Earth's (named after asteroid 1862 Apollo). $a>1.0$ AU, $q<1.017$ AU
Amors	Earth-approaching NEAs with orbits exterior to Earth's but interior to Mars' (named after asteroid 1221 Amor). $a>1.0$ AU, $1.017<q<1.3$ AU
PHAs	Potentially Hazardous Asteroids: NEAs whose Minimum Orbit Intersection Distance (MOID) with the Earth is 0.05 AU or less and whose absolute magnitude (H) is 22.0 or brighter. $MOID<=0.05$ AU, $H<=22.0$

NEO Groups: In terms of orbital elements, NEOs are asteroids and comets with perihelion distance q less than 1.3 AU. Near-Earth Comets (NECs) are further restricted to include only short-period comets (i.e orbital period P less than 200 years). The vast majority of NEOs are asteroids, referred to as Near-Earth Asteroids (NEAs). NEAs are divided into groups (Aten, Apollo, Amor) according to their perihelion distance (q), aphelion distance (Q) and their semi-major axes (a).

Potentially hazardous asteroids (PHAs) are currently defined based on parameters that measure the asteroid's potential to make threatening close approaches to the Earth. Specifically, all asteroids with an Earth Minimum Orbit Intersection Distance (MOID) of 0.05 AU or less and an absolute magnitude (H) of 22.0 or less are considered PHAs. In other words, asteroids that can't get any closer to the Earth (i.e. MOID) than 0.05 AU (roughly 7,480,000 km or 4,650,000 mi) or are smaller than about 150 m in diameter are not considered PHAs. There are currently 639 known PHAs. This "potential" to make close Earth approaches does ***not*** mean a PHA ***will*** impact the Earth. It only means there is a possibility for such a threat. By monitoring these PHAs and updating their orbits as new observations become available, we can better predict the close-approach statistics and thus their Earth-impact threat.

(Adapted from http://neo.jpl.nasa.gov/neo/)

METEOR SHOWERS visible from the Southern Hemisphere

SHOWER NAME	DURATION	MAX. ACTIVITY DATE	MAX COUNT PER HOUR	RADIANT		
				RA. (h m)	Dec. (°)	Size (°)
delta-Cancrids	Jan 01 - Jan 24	Jan 08	4	08 40	+20	5 - 10
alpha-Centaurids	Jan 28 - Feb 21	Feb 09	20	14 00	-59	4
delta-Leonids	Feb 15 - Mar 10	Feb 26	2	11 12	+16	5
gamma-Normids	Feb 25 - Mar 22	Mar 14	8	16 36	-51	5
Virginids	Jan 25 - Apr 15	Mar 24	5	13 00	-04	10 - 15
pi-Puppids	Apr 15 - Apr 28	Apr 23	periodic, <40	07 20	-45	5
eta-Aquarids	Apr 19 - May 28	May 05	60	22 32	-01	4
Sagittarids	Apr 15 - Jul 15	May 19	5	16 28	-22	10 - 15
Pegasids	Jul 07 - Jul 13	Jul 09	variable	22 40	+15	5
July Phoenicids	Jul 10 - Jul 16	Jul 13	variable, 3-10	02 08	-48	2
Pisces Austrinids	Jul 15 - Aug 10	Jul 27	5	22 44	-30	10 - 15
Southern delta-Aquarids	Jul 12 - Aug 19	Jul 27	20	22 36	-16	5
alpha-Capricornids	Jul 03 - Aug 15	Jul 29	4	20 28	-10	8
Southern iota-Aquarids	Jul 25 - Aug 15	Aug 04	2	22 16	-15	2
Northern delta-Aquarids	Jul 15 - Aug 25	Aug 08	4	22 20	-05	5
Northern iota-Aquarids	Aug 11 - Aug 31	Aug 19	3	21 48	-06	5
Piscids	Sep 01 - Sep 30	Sep 19	3	00 20	-01	5
epsilon-Geminids	Oct 14 - Oct 27	Oct 18	2	06 48	+27	5
Orionids	Oct 02 - Nov 07	Oct 21	23	06 20	+16	20
Southern Taurids	Oct 0 1 - Nov 25	Nov 05	5	03 28	+13	5 - 10
Northern Taurids	Oct 01 - Nov 25	Nov 12	5	03 52	+22	5 - 10
Leonids	Nov 14 - Nov 21	Nov 17	varies to 1000+	10 12	+22	5
alpha-Monocerotids	Nov 15 - Nov 25	Nov 22	variable	07 48	+01	5
chi-Orionids	Nov 26 - Dec 15	Dec 02	3	05 28	+23	8
Phoenicids	Nov 28 - Dec 09	Dec 06	variable	01 12	-53	5
Puppid-Velids	Dec 01 - Dec 15	Dec 06	10	08 12	-45	10
Monocerotids	Nov 27 - Dec 17	Dec 08	3	06 40	+08	5
sigma-Hydrids	Dec 03 - Dec 15	Dec 11	2	08 28	+02	5
Geminids	Dec 07 - Dec17	Dec 14	120	07 28	+33	5
Coma Berenicids	Dec 12 - Jan 23	Dec 19	5	11 40	+25	5

STARS & NON-STELLAR OBJECTS

BRIGHT STARS (EPOCH J2000.0)

DESIGNATION	NAME	CONSTELLATION	RA			DECLINATION			APP. MAG*	ABS. MAG**	SPECTRAL TYPE	PARA-LLAX	DIST.	DIST.
			h	m	s	°	′	″				″	ly	pc
1	Sun								-26.7	+4.8	G2V			
2 α CMa	Sirius	Canis Major	06	45	08.9	-16	42	58	-1.47	1.4	A1V	0.379	8.6	2.6
3 α Car	Canopus	Carina	06	24	20.1	-52	41	44	-0.72	-5.7	F0II	0.010	330	100
4 α Cen	Rigil Kent	Centaurus	14	39	36.2	-60	50	08	-0.27	4.1	G2V+K1V	0.742	4.4	1.3
5 α Boo	Arcturus	Bootes	14	15	39.7	+19	10	57	-0.04	-0.3	K1.5III	0.089	36.0	11.0
6 α Lyr	Vega	Lyra	18	36	56.3	+38	47	01	0.03	0.6	A0V	0.129	25.3	7.8
7 α Aur	Capella	Auriga	05	16	41.4	+45	59	53	0.08	-0.5	G5IIIe+G0III	0.077	42.3	13.0
8 β Ori	Rigel	Orion	05	14	32.3	-08	12	06	0.12	-6.9	B8Ia	0.004	820	250
9 α CMi	Procyon	Canis Minor	07	39	18.1	+05	13	30	0.34	2.6	F5 IV-V	0.286	11.4	3.5
10 α Eri	Achenar	Eridanus	01	37	42.8	-57	14	12	0.50	-2.7	B3Vpe	0.023	143	44
11 α Ori	Betelgeuse	Orion	05	55	10.3	+07	24	25	0.58	-4.9	M2Ib	0.008	550	125
12 β Cen	Hadar	Centaurus	14	03	49.4	-60	22	23	0.60	-5.5	B1III	0.006	550	170
13 α Aql	Altair	Aquila	19	50	47.0	+08	52	06	0.77	2.2	A7V	0.194	16.8	5.2
14 α Cru	Acrux	Crux	12	26	35.9	-63	05	56	0.77	-4.2	B0.5IV+B1V	0.010	330	100
15 α Tau	Aldebaran	Taurus	04	35	55.2	+16	30	33	0.85	-0.7	K5III	0.050	65.0	20.0
16 α Vir	Spica	Virgo	13	25	11.6	-11	09	41	1.04	-3.6	B1III-IV+B2V	0.012	270	83
17 α Sco	Antares	Scorpius	16	29	24.5	-26	25	55	1.09	-5.4	M1.5Ib+B4V	0.005	650	200
18 β Gem	Pollux	Gemini	07	45	19.0	+28	01	34	1.15	1.1	K0IIIb	0.097	33.6	10.3
19 α PsA	Formalhaut	Piscis Austrinus	22	57	39.0	-29	37	20	1.16	1.7	A3V	0.130	25.1	7.7
20 α Cyg	Deneb	Cygnus	20	41	25.9	+45	16	49	1.25	-8.8	A2Iae	0.001	3300	1000
21 β Cru	Mimosa	Crux	12	47	43.3	-59	41	20	1.30	-3.9	B0.5IV	0.009	360	110
22 α Leo	Regulus	Leo	10	08	22.3	+11	58	02	1.35	-0.5	B7V	0.042	78.0	24.0
23 ϵ CMa	Adhara	Canis Major	06	58	37.5	-28	58	20	1.51	-4.0	B2Iab	0.008	410	125
24 α Gem	Castor	Gemini	07	34	35.9	+31	53	18	1.59	0.6	A2Vm	0.063	52.0	15.9
25 λ Sco	Shaula	Scorpius	17	33	36.5	-37	06	14	1.62	-4.9	B2IV	0.005	650	200
26 γ Cru	Gacrux	Crux	12	31	10.0	-57	06	48	1.63	-0.5	M3.5III	0.037	88.0	27.0
27 γ Ori	Bellatrix	Orion	05	25	07.9	+06	20	59	1.64	-2.8	B2III	0.013	250	77
28 β Tau	Alnath	Taurus	05	26	17.5	+28	36	27	1.68	-1.3	B7III	0.025	130	40
29 β Car	Miaplacidus	Carina	09	13	12.0	-69	43	02	1.70	-1.0	A2IV	0.029	110	34
30 ϵ Ori	Alnilam	Orion	05	36	12.8	-01	12	07	1.70	-6.8	B0Iab	0.002	1600	500

* Apparent Magnitude
** Absolute Magnitude

The brightness of stars

How bright a star appears is called **apparent magnitude** by astronomers. This depends on three factors:

1. *distance from Earth,*
2. *size and*
3. *how much light it emits per square metre from its outer layers.*

The brightest star in the sky is our Sun. It is not a particularly big or bright star, but it is the nearest star to us.

Astronomers measure the brightness of the stars on a scale called the **magnitude** scale. This scale has descended to us from ancient times when Hipparchus, a Greek astronomer, classified the stars by their brightness and used the word magnitude to describe their relative brightness. In Hipparchus' system a very bright star would have a magnitude of 1 and a very faint star a magnitude of 6. **The smaller the number, the brighter the star**.

Accurate measurements of the brightness of stars have showed that a magnitude 1 star emits 100 times more energy than a magnitude 6 star. Apparently, the human eye responds in a logarithmic way to differing light levels. So a difference in magnitude of 1 corresponds to about a factor of 2.5 in energy. A magnitude system roughly consistent with that of Hipparchus has been established by modern astronomers, but now each star can have its magnitude accurately measured.

A powerful telescope can detect very faint stars beyond magnitude 20. Under very clear, dark skies, stars with a magnitude of about 6 are detectable by the unaided eye. Nearly 3,000 stars are visible to the unaided eye in good conditions. The very brightest planets have a magnitude of -1 to -4. Unfortunately, light pollution from household lighting and street lamps reduces the number of stars visible in urban areas compared to a dark site.

CLOSE STARS (EPOCH J2000.0)

DESIGNATION	NAME	CONSTELLATION	RA			DEC.			APP. MAG*	ABS. MAG**	SPECTRAL TYPE	PARA-LLAX ″	PROPER MOTION ″/year	DIST. ly	DIST. pc
			h	m	s	°	′	″							
1	Sun								-27	4.8	G2 V				
2 α Cen C	Proxima Cen	Centaurus	14	29	42.9	-62	40	46	11.05	15.49	M5.5Ve	0.772	3.85	4.22	1.30
α Cen A	Rigil Kentaurus	Centaurus	14	39	36.5	-60	50	02	-0.01	4.34	G2V	0.742	3.71	4.39	1.35
α Cen B	Rigil Kentaurus	Centaurus	14	39	35.1	-60	50	14	1.33	5.68	K1V	0.742	3.73	4.39	1.35
3	Barnard's Star	Ophiuchus	17	57	48.5	+04	41	36	9.54	13.24	M4Ve	0.549	10.37	5.94	1.82
4 G045-020	Wolf 359	Leo	10	56	29.0	+07	00	52	13.54	16.68	M5.5	0.425	4.71	7.67	2.35
5	Lalande 21185	Ursa Major	11	03	20.2	+35	58	12	7.49	10.46	M2V	0.392	4.81	8.32	2.55
6 α CMa A	Sirius A	Canis Major	06	45	08.9	-16	42	58	-1.47	1.42	A1V	0.379	1.34	8.60	2.64
α CMa B	Sirius B	Canis Major	06	45	08.9	-16	43	06	8.44	11.33	DA	0.379	1.33	8.60	2.64
7 L 726-8 A	BL Cet	Cetus	01	39	01.5	-17	57	02	12.57	15.43	M5.5V:e	0.374	3.37	8.72	2.67
L 726-8 B	UV Cet	Cetus	01	39	01.5	-17	57	04	12.52	15.42	M5.5e	0.381	3.37	8.56	2.62
8	Ross 154	Sagittarius	18	49	49.4	-23	50	10	10.95	13.58	M3.5	0.336	0.67	9.70	2.98
9	Ross 248	Andromeda	23	41	55.2	+44	10	38	12.28	14.77	M5	0.315	1.62	10.3	3.17
10 ε Eri	Epsilon Eridani	Eridanus	03	32	55.8	-09	27	30	3.73	6.19	K2 V	0.311	0.98	10.5	3.22
11 Gl 887	Lacaille 9352	Piscis Austrinus	23	05	52.0	-35	51	11	7.34	9.75	M0.5	0.304	6.90	10.7	3.29
12 G010-050	Ross 128	Virgo	11	47	44.4	+00	48	16	11.08	13.47	M4	0.300	1.36	10.9	3.33
13 G156-031 A	L 789-6 A	Aquarius	22	38	33.8	-15	18	03	13.3	15.69	M5.5	0.300	3.24	10.9	3.33
G156-031 B	L 789-6 B	Aquarius	22	38	33.8	-15	18	03	13.3	15.69	M5	0.300	3.24	10.9	3.33
G156-031 C	L 789-6 C	Aquarius	22	38	37.3	-15	17	07	14.0	16.34	M7	0.294	3.25	11.1	3.40
14 α CMi A	Procyon A	Canis Minor	07	39	18.1	+05	13	30	0.34	2.62	F5IV-V	0.286	1.26	11.4	3.50
α CMi B	Procyon B	Canis Minor	07	39	19.7	+05	15	25	10.7	12.98	-	0.286	1.25	11.4	3.50
15 Gl 820 A	61 Cygni A	Cygnus	21	06	53.9	+38	44	58	5.21	7.50	K5V	0.287	5.28	11.4	3.48
Gl 820 B	61 Cygni B	Cygnus	21	06	55.3	+38	44	31	6.03	8.30	K7V	0.285	5.17	11.4	3.51
16 Gl 725 A	Struve 2398 A	Draco	18	42	46.7	+59	37	49	8.91	11.15	M3V	0.280	2.24	11.6	3.57
Gl 725 B	Struve 2398 B	Draco	18	42	46.9	+59	37	37	9.69	11.96	M3.5	0.284	2.31	11.5	3.52
17 BD +43°44	Groombridge 34 A	Andromeda	00	18	22.9	+44	01	23	8.09	10.33	M1.5V	0.280	2.92	11.6	3.57
	Groombridge 34 B	Andromeda	00	18	25.8	+44	01	38	11.04	13.28	M3.5	0.280	2.93	11.6	3.57
18 ε Ind A	Gl 845 A	Indus	22	03	21.6	-56	47	10	4.69	6.89	K4V	0.276	4.70	11.8	3.62
ε Ind B	Gl 845 B	Indus	22	03	21.6	-56	47	10	-	-	T2.5	0.276	4.70	11.8	3.62
19 G51-15	GJ 1111	Cancer	08	29	49.5	+26	46	32	14.81	17.01	M6	0.276	1.27	11.8	3.62
20 τ Cet	Gl 71	Cetus	01	44	04.1	-15	56	15	3.50	5.69	G8V	0.274	1.92	11.9	3.65
21 L 725-32	YZ Ceti	Cetus	01	12	30.6	-16	59	56	11.6	13.75	M4.5	0.269	1.37	12.1	3.72
22 BD +5°1668	Luyten's Star	Canis Minor	07	27	24.5	+05	13	33	9.89	11.99	M3.5	0.263	3.74	12.4	3.80
23 Gl 191	Kapteyn's Star	Pictor	05	11	40.6	-45	01	06	8.89	10.92	M1	0.255	8.66	12.8	3.92
24 Gl 825	Lacaille 8760	Microscopium	21	17	15.3	-38	52	02	6.68	8.70	K7	0.253	3.45	12.9	3.95
25 L 372-58	GJ 1061	Horologium	03	35	59.6	-44	30	46	13.03	14.87	M5.5	0.233	0.83	14.0	4.29

* Apparent Magnitude
** Absolute Magnitude

Star names

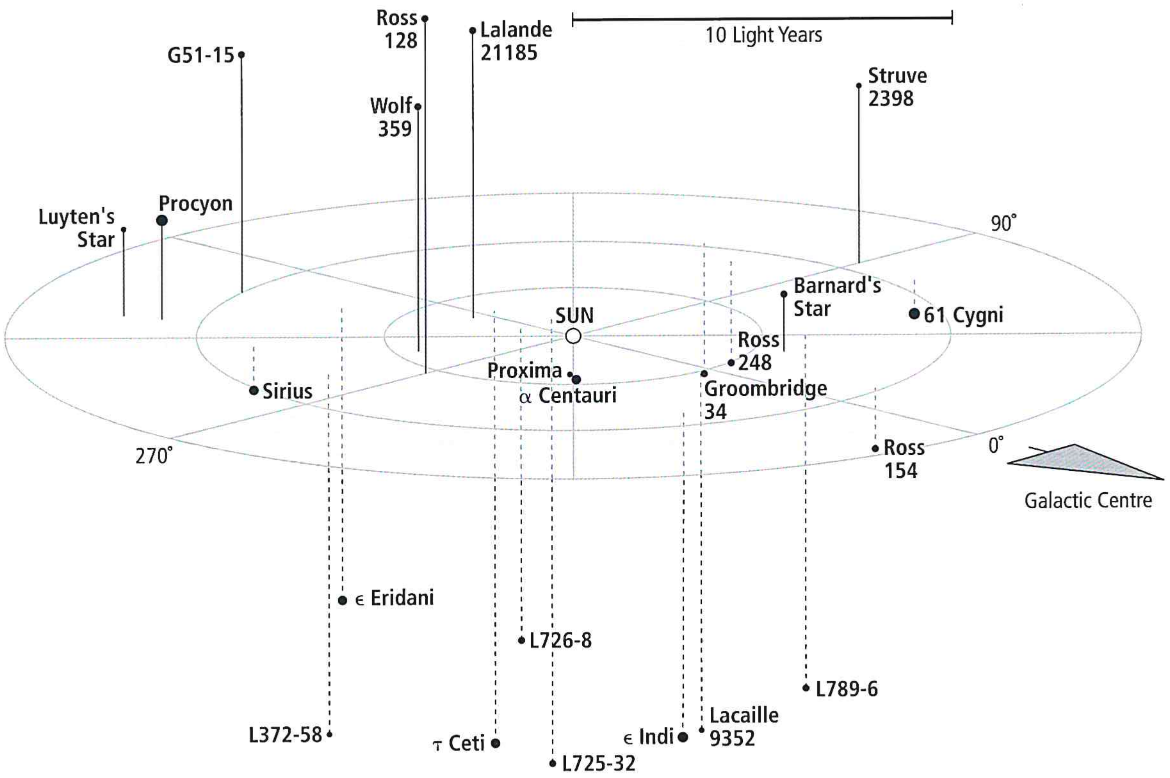
Many of the brighter stars were named in ancient times. Usually, the name referred to its place or association in its constellation. About 1,000 years ago Arab scholars kept the science of astronomy progressing and many star names are derived from their work.

In 1603, Johannes Bayer published an accurate atlas of the stars and constellations. He utilised a new system to name the stars within a constellation. The brightest star in a constellation was designated α (alpha), and the next brightest was β (beta), and so on through the Greek alphabet (see section: ***Background & General Information***). Unfortunately, Bayer was not rigorous in the application of this system and so there are anomalies such as α Orionis (Betelgeuse) being fainter than β Orionis (Rigel).

Some of the fainter stars (but still visible to the unaided eye) are often referred to by their Flamsteed number. John Flamsteed (1646-1719) compiled a star catalogue which was published in 1725, six years after his death. In this catalogue, called the *Historia Coelestis Britannica*, Flamsteed assigned numbers to the stars within each constellation according to the stars' right ascensions. For example, the brightest star in the constellation Taurus is Aldebaran (*the follower* – in 'corrupted' Arabic), also designated α Tauri in Bayer's system and 87 Tauri according to Flamsteed's work.

Many stars have been catalogued and named in a variety of astronomical research programmes. Most names are now based on the position (right ascension and declination) of the star in the sky. Other naming systems are derived from the details of the observing equipment and how it has mapped the sky. Other names are based solely on the star's sequence in a published catalogue. For example, Aldebaran is also BD +16 629 in the Bonner Durchmusterung (Bonn Survey), BS 1457 in the Yale Bright Star Catalog, HD 29139 in the Henry Draper Catalog of stellar spectra, SAO 94027 in the Smithsonian Astrophysical Observatory Catalog, and HIP 21421 in the Hipparcos Catalogue of accurate star positions.

Diagram showing stars closest to the Solar System.



Spectral classes of main sequence stars

Stars are classified according to the temperature of their photosphere (the observable "surface" of the star). Most stars are powered by thermonuclear reactions in their interiors. Middle aged stars produce energy (light) by converting hydrogen to helium. Such stars are said to be on the Main Sequence.

Class	Colour	Representative Temperature	Representative Mass	Representative Radius	Representative density	Some Stars of this Colour
O	Blue	50,000K	40	18	0.01	None visible to the naked eye
B	Blue	30,000K	7	4	0.2	Achernar, Rigel, Acrux
A	White	10,000K	2	2	0.6	Sirius, Fomalhaut, Canopus
F	White-Yellow	7,000K	1.5	1.2	1.1	Procyon
G	Yellow	6,000K	1	1	1.6	Sun
K	Orange	5,000K	0.7	0.7	2.4	Arcturus, Aldebaran, Pollux
M	Red	3,500K	0.2	0.3	10.0	Betelgeuse, Antares

***Note**: At these temperatures, degrees Kelvin (K) is approximately equal to the same number of degrees Celsius. Typical star masses and typical star radii are given for each spectral class. These two figures are expressed relative to the Sun's mass (1.99 x 10^{30} kg) and the Sun's radius (6.96 x 10^{5} km), respectively. Average density is given in grams/cm^{3}; for comparison, water has a density of 1 gram/cm^{3}.*

NON-STELLAR OBJECTS (EPOCH J2000.0)

NAME	RA h m	DEC. ° ′	SIZE ′	CONST.	TYPE	MAG.	DESCRIPTION
NGC 55	00 15.1	-39 13	30 x 63	Scl	Spiral galaxy	8.2	A bright galaxy in the Sculptor Group
NGC 104	00 24.1	-72 05	31	Tuc	Globular cluster	4.0	47 Tucanae, one of the finest globular clusters
NGC 224	**00 42.8**	**+41 16**	**186 x70**	**And**	**Spiral galaxy**	**4.5**	**M31, The 'Andromeda Galaxy'**
NGC 253	00 47.5	-25 17	26 x 6	Scl	Spiral galaxy	7.1	'Silver Coin' galaxy. Large, bright edge-on spiral
SMC	00 52.7	-72 49	300	Tuc	Galaxy	2.2	Small Magellanic Cloud. Visible to unaided eye from dark sky
Pleiades	03 47.0	+24 07	110	Tau	Open cluster	1.5	M45 or 'Seven Sisters'. Naked eye cluster, the brighter stars mag. 2
Hyades	04 26.9	+15 52	330	Tau	Open cluster	0.8	A naked eye, 'V' shaped cluster. 28 stars, the brighter mag. 3 and 4

NON-STELLAR OBJECTS (continued)

NAME	RA hh mm	DEC. ° '	SIZE	CONST.	TYPE	MAG.	DESCRIPTION
LMC	05 23.6	-69 45	600	Dor	Galaxy	0.1	Large Magellanic Cloud. Visible to unaided eye from dark sky
NGC 1976	05 35.3	-05 23	90 x 60	Ori	Gaseous nebula	5.0	M42, 'Orion Nebula', emission and reflection nebula
NGC 2070	05 38.7	-69 06	30 x 20	Dor	Emission nebula	7.2	30 Doradus, 'Tarantula Nebula', bright complex looped structure
NGC 2169	06 08.5	+13 58	7	Ori	Open cluster	5.9	Rich loose cluster, 30 stars magnitude 7 and fainter
NGC 2168	06 08.9	+24 20	28	Gem	Open cluster	5.1	M35, 200 stars, magnitude range 9 to 16, no central concentration
NGC 2244	06 32.3	+04 52	24	Men	Open cluster	4.8	Rich cluster of 100 stars, with nebulosity (Rosette Nebula)
NGC 2264	06 41.1	+09 53	20	Men	Open cluster	3.9	40 stars, large brightness range, involved in nebulosity (Cone Nebula)
NGC 2287	06 46.9	-20 44	38	CMa	Open cluster	4.5	M41, 80 stars 7th magnitude and fainter with 6.9 mag. red star near centre
NGC 2301	06 51.8	+00 28	12	Mon	Open cluster	6.0	Rich cluster, 80 stars, large magnitude range, central concentration
NGC 2362	07 18.8	-24 57	8	CMa	Open cluster	4.1	60 stars, large brightness range (4th mag. down), concentrated centre
NGC 2422	07 36.6	-14 30	30	Pup	Open cluster	4.4	M47, large coarse cluster with 30 bright and faint stars
NGC 2437	07 41.8	-14 49	27	Pup	Open cluster	6.1	M46, rich open cluster, 100 stars, planetary nebula NGC2438 in same field
NGC 2447	07 44.6	-23 52	22	Pup	Open cluster	6.2	M93, 80 stars magnitude 8 to 13 with strong central concentration
NGC 2451	07 45.4	-37 58	45	Pup	Open cluster	3.5	Rich in stars with slight central concentration
NGC 2477	07 52.3	-38 33	27	Pup	Open cluster	5.8	~160 stars around 10 - 12th magnitude, strong central concentration
NGC 2516	07 58.3	-60 52	29	Car	Open cluster	3.8	80 stars 6th magnitude and fainter, strong central concentration
NGC 2547	08 10.4	-49 10	74	Vel	Open cluster	4.7	Rich in stars with strong central concentration. Brightest stars mag. 6
NGC 2548	08 13.8	-05 48	54	Hya	Open cluster	5.8	M48, Large cluster of 80 stars 8 to 13th magnitude, central concentration
NGC 2632	08 40.4	+19 40	95	Cnc	Open cluster	3.1	M44, 'Praesepe' or 'Beehive Cluster', very large cluster, 50 stars
IC 2391	08 40.2	-53 04	50	Vel	Open cluster	2.5	Moderately rich in bright (about mag. 3) and faint stars
IC 2395	08 42.6	-48 07	7	Vel	Open cluster	4.6	40 stars 6th magnitude and fainter
NGC 2808	09 12.0	-64 52	15	Car	Globular cluster	6.2	Large and rich, compressed centre, stars 13 to 15th magnitude
NGC 3114	10 02.7	-60 07	35	Car	Open cluster	4.2	Rich cluster, stars 9 to 14th magnitude, slight central concentration
NGC 3132	10 07.0	-40 26	0.5	Vel	Planetary nebula	9.9	The 'Eight Burst Nebula', ring and disk, 10th magnitude central star
IC 2602	10 43.3	-64 20	50	Car	Open cluster	1.6	Rich in stars, strong central concentration, brightest stars mag. 3
NGC 3372	10 44.3	-59 53		Car	Emission nebula	varies	The 'Eta Carinae Nebula', very bright, prominent dark lanes
NGC 3532	11 06.6	-58 44	55	Car	Open cluster	3.0	Rich and large, slight central concentration, 150 stars 7 to 12th magnitude
NGC 3766	11 36.2	-61 38	12	Cen	Open cluster	5.3	Rich cluster, 100 stars magnitude range 7 to 12th
NGC 4755	12 53.8	-60 22	10	Cru	Open cluster	5.2	The 'Jewel Box', rich in stars, large brightness range
NGC 4945	13 05.4	-49 28	23 x 6	Cen	Spiral galaxy	8.2	Large edge on spiral, good field, another small galaxy in same field
NGC 5128	13 25.5	-43 01	31 x 23	Cen	Galaxy	7.0	'Centaurus A', bright sphere crossed by dark lane, radio source
NGC 5139	13 26.8	-47 29	36	Cen	Globular cluster	3.7	Omega Centauri, one of the finest globular clusters
NGC 5272	13 42.2	+28 23	16	CVn	Globular cluster	6.2	M3, large bright globular cluster, brightens rapidly towards the middle
NGC 5281	13 46.5	-62 55	4	Cen	Open cluster	5.9	40 stars, moderately rich in bright and faint stars, magnitudes 6 to 12
NGC 5617	14 29.8	-60 43	10	Cen	Open cluster	6.3	80 stars, large brightness range, strong central concentration
NGC 5904	15 18.6	+02 05	20	Ser	Globular cluster	5.6	M5, bright, large very compressed in middle, slightly oval in shape
NGC 6025	16 03.7	-60 30	12	TrA	Open cluster	5.1	60 stars, large brightness range, slight central concentration
NGC 6067	16 13.2	-54 13	12	Nor	Open cluster	5.6	100 stars, large brightness range, strong central concentration
NGC 6087	16 18.9	-57 54	12	Nor	Open cluster	5.4	40 stars, moderate brightness range, slight central concentration
NGC 6121	16 23.6	-26 32	26	Sco	Globular cluster	5.6	M4, conspicuous globular near Antares, one of the nearest
NGC 6124	16 25.6	-40 40	29	Sco	Open cluster	5.8	100 stars, large brightness range, strong central concentration
NGC 6193	16 41.3	-48 46	14	Ara	Open cluster	5.2	Few stars, large brightness range, slight central concentration
NGC 6205	**16 41.7**	**+36 28**	**17**	**Her**	**Globular cluster**	**5.8**	**M13, the 'Great Hercules Cluster', showpiece of northern skies**
NGC 6231	16 54.2	-41 50	14	Sco	Open cluster	2.6	A few stars with strong central concentration. Brightest stars mag. 5
NGC 6405	17 40.1	-32 13	20	Sco	Open cluster	4.2	M6, the 'Butterfly Cluster', 80 stars, large brightness range
NGC 6397	17 40.7	-53 40	26	Ara	Globular cluster	5.7	Loose, scattered structure, one of the nearest of the globulars
NGC 6475	17 53.9	-34 49	80	Sco	Open cluster	4.5	M7, 80 stars brighter than 1 10th magnitude, large brightness range
NGC 6494	17 56.8	-19 01	27	Sgr	Open cluster	5.5	M23, 150 stars, moderate brightness range, lies in good star field
NGC 6514	18 02.4	-23 02	28	Sgr	Gaseous nebula	6.3	M20, 'Trifid Nebula', emission and reflection nebulosity cut by dark lanes
NGC 6523	18 03.6	-24 23	45 x 30	Sgr	Emission nebula	5.8	M8, 'Lagoon', densest section known as the 'Hourglass', dark lane
NGC 6611	18 18.8	-13 47	7	Ser	Open cluster	6.0	M16, 100 bright and faint stars in the 'Eagle Nebula'
IC 4725	18 31.9	-19 15	29	Sgr	Open cluster	6.2	M25, 30 stars loosely scattered
NGC 6656	18 36.4	-23 54	24	Sgr	Globular cluster	5.1	M22. Fine globular, only Omega Centauri and 47 Tucanae are brighter
NGC 6705	18 51.1	-06 16	14	Set	Open cluster	5.8	M11, the 'Wild Duck Cluster', rich and compact open cluster
NGC 7009	21 04.2	-11 22	0.5	Aqr	Planetary nebula	12.8	The 'Saturn Nebula', ring structure in a larger and fainter halo
NGC 7078	21 30.0	+12 10	12	Peg	Globular cluster	6.2	M15, bright, irregularly shaped, well resolved into faint stars
NGC 7293	22 29.6	-20 50	13	Aqr	Planetary nebula	13.5	The 'Helix Nebula', ring structure in a larger and fainter disk

The data in **bold** denotes objects that are difficult to view from southern parts of WA.

Astronomy on the Internet

There are many Internet sites available for aspiring amateur astronomers, most of which are very user friendly, and full of information. The following list of sites has been found to be quite useful. Please note that the Internet is a dynamic medium so access to sites can change without notice, while new sites are becoming available all the time.
This is a small list – each of the sites mentioned will have links to more related sites.

Perth Observatory

http://www.wa.gov.au/perthobs

- ***Astronomy News***: Updated regularly, this section contains the weekly night sky column, plus notification of current phenomena and topical events.
- ***Astronomy Information***: This gives information (small images) of planets, comets, stars etc. All of this information is taken from the Perth Observatory Project Kit.
- ***Tours***: Details of services for the public. For availability, contact Perth Observatory. Daytime guided tours and evening star viewing available.
- ***Current Phenomena***: Programs of specific interest (Galileo, Hubble Space Telescope, eclipses etc) are given links from here. Also Sun and Moon rise/set times for Perth.
- ***Links***: This section links the user to all areas of astronomical interest.

NASA Homepage

http://www.nasa.gov/

This is a good starting place for many NASA projects – especially current missions. When a shuttle mission is in orbit, this will give a link to the current shuttle home page, with associated projects and experiments.

Astronomy Images

http://wfpc2.jpl.nasa.gov

Images from the Hubble Space telescope.

Hubble Space Telescope

http://oposite.stsci.edu/pubinfo/

The Hubble Space Telescope is managed through the Space Telescope Science Institute in Baltimore. Many HST images are available, even those several years old.

Sky and Telescope Magazine

http://www.skypub.com/

This magazine is the premier astronomy magazine for amateur astronomers. Sky Publishing put out a weekly update of all astronomical events in non-technical language along with summaries of press releases. The site can also provide some basic astronomical information.

Sun

http://sohowww.nascom.nasa.gov/

Current real time Sun images, including animated GIFs of solar flares. Also information about auroras.

Sunrise/set times

http://www.auslig.gov.au/geodesy/astro

Type in your latitude, longitude and Time Zone for astronomical phenomena at any place – interactive.

Moon Phases

http://sunearth.gsfc.nasa.gov/eclipse/phase/phase2001.html

Dates and times for moon phases (in UT: WAST = UT + 8hrs).

Eclipses

http://sunearth.gsfc.nasa.gov/eclipse/eclipse.html

Provides a wealth of information concerning both solar and lunar eclipses.

Current Almanac

http://skyandtelescope.com/observing/almanac

Can be set for your location. Sun and Moon, rise and set times, planet visibility, plus Space Station viewing times are available at this site.

Planets

http://www.nineplanets.org

Latest Information on all the planets – an excellent site.

Solar System Conditions

http://www.spaceweather.com

Current state of the solar winds, plus aurora predictions and asteroid approaches.

ISS, Iridium Satellites, Satellites

http://www.heavens-above.com

Input your specific site, and bookmark for your location. This gives passages of all satellites, or ISS (International Space Station), or the Iridium satellite flashes visible from your site, with specific times.

Weather

http://www.bom.gov.au/weather/wa

Weather maps and predictions, wind forecasts, charts and current conditions.

Constellations

Constellations are a relatively arbitrary grouping of stars in the sky. They are arbitrary in the sense that the stars are not necessarily related in any way, or even close to one another, they just lie in the same direction in the sky. Also, in ancient times some stars were grouped together in a constellation because they were reminiscent of the outline, or rough shape, of an animal, object, or a mythological being. Different cultures most times defined different constellations for the same grouping of stars, but sometimes they were quite similar. Identifying a constellation by eye is sometimes just a matter of 'joining the dots' defined by the stars and using some imagination. Some constellations are not easily identified in this way as the relationship of stars to object is abstract or obscure.

Some of the constellations are descended from catalogues created by the ancient Greeks around 2,000 years ago. The most influential of these catalogues is the *Almagest* by Ptolemy of Alexandria (AD 73 - AD 151) in which he mentions 48 constellations that were visible from the Northern Hemisphere. Naturally, these constellations descended from earlier Egyptian and Mesopotamian cultures. This catalogue had an influence lasting nearly 1,200 years and was the foundation of the astronomy accomplished by Arabic and Medieval scholars. In fact, the title *Almagest* is a corruption of the Arabic, Al-mijisti, which roughly translates to *the Magnificent* – such was this culture's appreciation of its scholarly importance.

A little more than half of the constellations in use today originated from ancient times. The others were defined by European astronomers and cartographers as the Southern Hemisphere began to be explored in the 16th Century.

The most notable of these astronomers was Nicolas Louis de Lacaille (1713-1762). After an observing expedition to South Africa, he named 14 new constellations in the uncharted parts of southern sky. The constellations he defined represented equipment (mostly scientific) in use at that time.

In 1930 the International Astronomical Union (the organisation of professional astronomers) fixed the names and boundaries of the constellations. They defined 88 constellations in all, covering the entire sky (see table below). They generally follow the patterns of the most common constellations defined in earlier times. Strict definitions were required because prior to that date mapmakers and astronomers could define constellations as they pleased. Sometimes this was undertaken in order to obtain favour from a patron.

The table also provides the Latin 'genitive' case of the constellation names. This case is often referred to as the possessive case, as that is the most similar English language case comparison. It expresses possession, origin, source, etc. and in Latin grammar is shown by inflection of nouns, pronouns, and adjectives. With respect to the constellations, this case is used to show that the location of a star, or other object, lies within the boundaries of a constellation. For example, the brightest star in Taurus, Aldebaran, becomes α Tauri.

Culmination occurs when the mid point of a constellation is highest in the sky around midnight.

CONSTELLATIONS

DESIGNATION	GENITIVE	ABBREV.	CULMINATION	MEANING
Andromeda	Andromedae	And	Nov 23	The Princess of Ethiopia
Antlia	Antliae	Ant	Apr 10	The Air Pump
Apus	Apodis	Aps	Jul 05	The Bird of Paradise
Aquarius	Aquarii	Aqr	Oct 09	The Water Bearer
Aquila	Aquilae	Aql	Aug 30	The Eagle
Ara	Arae	Ara	Jul 25	The Altar
Aries	Arietis	Ari	Dec 14	The Ram
Auriga	Aurigae	Aur	Feb 04	The Charioteer
Bootes	Bootis	Boo	Jun 16	The Bear Driver
Caelum	Caeli	Cae	Jan 15	The Sculptor's Chisel
Camelopardus	Camelopardi	Cam	Feb 06	The Giraffe
Cancer	Cancri	Cnc	Mar 16	The Crab
Canes Venatici	Canum Venaticorum	CVn	May 22	The Hunting Dogs
Canis Major	Canis Majoris	CMa	Feb 16	The Greater Dog
Canis Minor	Canis Minoris	CMi	Feb 28	The Lesser Dog
Capricornus	Capricorni	Cap	Sep 22	The Sea Goat
Carina	Carinae	Car	Mar 17	The Keel (of Argo Navis)
Cassiopeia	Cassiopeiae	Cas	Nov 23	The Queen of Ethiopia
Centaurus	Centauri	Cen	May 14	The Centaur
Cepheus	Cephei	Cep	Nov 13	The King of Ethiopia
Cetus	Ceti	Cet	Nov 29	The Sea Monster (Whale)
Chamaeleon	Chamaeleontis	Cha	Apr15	The Chameleon
Circinus	Circini	Cir	Jun 14	The Compasses
Columba	Columbae	Col	Feb 01	Noah's Dove
Coma Berenices	Cornae Berenices	Corn	May 17	The Hair of Berenice
Corona Australis	Coronae Australis	CrA	Aug 14	The Southern Crown

CONSTELLATIONS (continued)

DESIGNATION	GENITIVE	ABBREV.	CULMINATION	MEANING
Corona Borealis	Coronae Borealis	CrB	Jul 03	The Northern Crown
Corvus	Corvi	Crv	May 12	The Crow
Crater	Crateris	Crt	Apr 26	The Cup
Crux	Crucis	Cru	May 12	The (Southern) Cross
Cygnus	Cygni	Cyg	Sep 13	The Swan
Delphinus	Delphini	Del	Sep 14	The Dolphin (Porpoise)
Dorado	Doradus	Dor	Jan 31	The Swordfish
Draco	Draconis	Dra	Jul 08	The Dragon
Equuleus	Equulei	Equ	Sep 22	The Foal
Eridanus	Eridani	Eri	Dec 25	The River
Fornax	Fornacis	For	Dec 17	The Laboratory Furnace
Gemini	Geminorum	Gem	Feb 19	The Twins
Grus	Gruis	Gru	Oct 12	The Crane
Hercules	Herculis	Her	Jul 28	Hercules (the hero)
Horologium	Horologii	Hor	Dec 25	The Pendulum Clock
Hydra	Hydrae	Hya	Apr 29	The Water Snake
Hydrus	Hydri	Hyi	Dec 10	The Southern Water Snake
Indus	Indi	Ind	Sep 26	The American Indian
Lacerta	Lacertae	Lac	Oct 12	The Lizard
Leo	Leonis	Leo	Apr 15	The Lion
Leo Minor	Leonis Minoris	LMi	Apr 09	The Lion Cub
Lepus	Leporis	Lep	Jan 28	The Hare
Libra	Librae	Lib	Jun 23	The Scales
Lupus	Lupi	Lup	Jun 23	The Wolf
Lynx	Lyncis	Lyn	Mar 05	The Lynx
Lyra	Lyrae	Lyr	Aug18	The Harp
Mensa	Mensae	Men	Jan 28	The Table Mountain
Microscopium	Microscopii	Mic	Sep, 18	The Microscope
Monoceros	Monocerotis	Mon	Feb 19	The Unicorn
Musca	Muscae	Mus	May 14	The Fly
Norma	Normae	Nor	Jul 03	The Carpenter's Square
Octans	Octantis	Oct	Circum	The Octant
Ophiuchus	Ophiuchi	Oph	Jul 26	The Serpent Bearer
Orion	Orionis	Ori	Jan 27	The Hunter
Pavo	Pavonis	Pav	Aug 29	The Peacock
Pegasus	Pegasi	Peg	Oct 16	The Winged Horse
Perseus	Persei	Per	Dec 22	Perseus (the hero)
Phoenix	Phoenicis	Phe	Nov 18	The Phoenix
Pictor	Pictoris	Pic	Jan 30	The Painter's Easel
Pisces	Piscium	Psc	Nov 11	The Fishes
Piscis Austrinus	Piscis Austrini	PsA	Oct 09	The Southern Fish
Puppis	Puppis	Pup	Feb 22	The Stern (of Argo Navis)
Pyxis	Pyxidis	Pyx	Mar 21	The Compass (of Argo Navis)
Reticulum	Reticuli	Ret	Jan 03	The Net
Sagitta	Sagittae	Sge	Aug 30	The Arrow
Sagittarius	Sagittarii	Sgr	Aug 21	The Archer
Scorpius	Scorpii	Sco	Jul 18	The Scorpion
Sculptor	Sculptoris	Scl	Nov 10	The Sculptor's Workshop
Scutum	Scuti	Sct	Aug 15	The Shield
Serpens	Serpentis	Ser	Jul 21	The Serpent
Sextans	Sextantis	Sex	Apr 08	The Sextant
Taurus	Tauri	Tau	Jan 14	The Bull
Telescopium	Telescopii	Tel	Aug 24	The Telescope
Triangulum	Trianguli	Tri	Dec 07	The Triangle
Triangulum Australe	Trianguli Australis	TrA	Jul 07	The The Southern Triangle
Tucana	Tucanae	Tuc	Nov 01	The Toucan
Ursa Major	Ursae Majoris	UMa	Apr 25	The Great Bear
Ursa Minor	Ursae Minoris	Umi	Jun 27	The Bear Cub
Vela	Velorum	Vel	Mar 30	The Sail (of Argo Navis)
Virgo	Virginis	Vir	May 26	The Virgin
Volans	Volantis	Vol	Mar 04	The Flying Fish
Vulpecula	Vulpeculae	Vul	Sep 08	The Fox

GREEK ALPHABET

Α	α	Alpha
Β	β	Beta
Γ	γ	Gamma
Δ	δ	Delta
Ε	ϵ	Epsilon
Ζ	ζ	Zeta
Η	η	Eta
Θ	θ	Theta
Ι	ι	Iota
Κ	κ	Kappa
Λ	λ	Lambda
Μ	μ	Mu
Ν	ν	Nu
Ξ	ξ	Xi
Ο	ο	Omicron
Π	π	Pi
Ρ	ρ	Rho
Σ	σ	Sigma
Τ	τ	Tau
Υ	υ	Upsilon
Φ	φ	Phi
Χ	χ	Chi
Ψ	ψ	Psi
Ω	ω	Omega

CALENDAR WITH JULIAN DATE AND DAY NUMBERS

DAY OF MONTH	JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE		
	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000
1	Sat	1	371.5	Tue	32	402.5	Tue	60	430.5	Fri	91	461.5	Sun	121	491.5	Wed	152	522.5
2	Sun	2	372.5	Wed	33	403.5	Wed	61	431.5	Sat	92	462.5	Mon	122	492.5	Thu	153	523.5
3	Mon	3	373.5	Thu	34	404.5	Thu	62	432.5	Sun	93	463.5	Tue	123	493.5	Fri	154	524.5
4	Tue	4	374.5	Fri	35	405.5	Fri	63	433.5	Mon	94	464.5	Wed	124	494.5	Sat	155	525.5
5	Wed	5	375.5	Sat	36	406.5	Sat	64	434.5	Tue	95	465.5	Thu	125	495.5	Sun	156	526.5
6	Thu	6	376.5	Sun	37	407.5	Sun	65	435.5	Wed	96	466.5	Fri	126	496.5	Mon	157	527.5
7	Fri	7	377.5	Mon	38	408.5	Mon	66	436.5	Thu	97	467.5	Sat	127	497.5	Tue	158	528.5
8	Sat	8	378.5	Tue	39	409.5	Tue	67	437.5	Fri	98	468.5	Sun	128	498.5	Wed	159	529.5
9	Sun	9	379.5	Wed	40	410.5	Wed	68	438.5	Sat	99	469.5	Mon	129	499.5	Thu	160	530.5
10	Mon	10	380.5	Thu	41	411.5	Thu	69	439.5	Sun	100	470.5	Tue	130	500.5	Fri	161	531.5
11	Tue	11	381.5	Fri	42	412.5	Fri	70	440.5	Mon	101	471.5	Wed	131	501.5	Sat	162	532.5
12	Wed	12	382.5	Sat	43	413.5	Sat	71	441.5	Tue	102	472.5	Thu	132	502.5	Sun	163	533.5
13	Thu	13	383.5	Sun	44	414.5	Sun	72	442.5	Wed	103	473.5	Fri	133	503.5	Mon	164	534.5
14	Fri	14	384.5	Mon	45	415.5	Mon	73	443.5	Thu	104	474.5	Sat	134	504.5	Tue	165	535.5
15	Sat	15	385.5	Tue	46	416.5	Tue	74	444.5	Fri	105	475.5	Sun	135	505.5	Wed	166	536.5
16	Sun	16	386.5	Wed	47	417.5	Wed	75	445.5	Sat	106	476.5	Mon	136	506.5	Thu	167	537.5
17	Mon	17	387.5	Thu	48	418.5	Thu	76	446.5	Sun	107	477.5	Tue	137	507.5	Fri	168	538.5
18	Tue	18	388.5	Fri	49	419.5	Fri	77	447.5	Mon	108	478.5	Wed	138	508.5	Sat	169	539.5
19	Wed	19	389.5	Sat	50	420.5	Sat	78	448.5	Tue	109	479.5	Thu	139	509.5	Sun	170	540.5
20	Thu	20	390.5	Sun	51	421.5	Sun	79	449.5	Wed	110	480.5	Fri	140	510.5	Mon	171	541.5
21	Fri	21	391.5	Mon	52	422.5	Mon	80	450.5	Thu	111	481.5	Sat	141	511.5	Tue	172	542.5
22	Sat	22	392.5	Tue	53	423.5	Tue	81	451.5	Fri	112	482.5	Sun	142	512.5	Wed	173	543.5
23	Sun	23	393.5	Wed	54	424.5	Wed	82	452.5	Sat	113	483.5	Mon	143	513.5	Thu	174	544.5
24	Mon	24	394.5	Thu	55	425.5	Thu	83	453.5	Sun	114	484.5	Tue	144	514.5	Fri	175	545.5
25	Tue	25	395.5	Fri	56	426.5	Fri	84	454.5	Mon	115	485.5	Wed	145	515.5	Sat	176	546.5
26	Wed	26	396.5	Sat	57	427.5	Sat	85	455.5	Tue	116	486.5	Thu	146	516.5	Sun	177	547.5
27	Thu	27	397.5	Sun	58	428.5	Sun	86	456.5	Wed	117	487.5	Fri	147	517.5	Mon	178	548.5
28	Fri	28	398.5	Mon	59	429.5	Mon	87	457.5	Thu	118	488.5	Sat	148	518.5	Tue	179	549.5
29	Sat	29	399.5				Tue	88	458.5	Fri	119	489.5	Sun	149	519.5	Wed	180	550.5
30	Sun	30	400.5				Wed	89	459.5	Sat	120	490.5	Mon	150	520.5	Thu	181	551.5
31	Mon	31	401.5				Thu	90	460.5				Tue	151	521.5			

DAY OF MONTH	JULY			AUGUST			SEPTEMBER			OCTOBER			NOVEMBER			DECEMBER		
	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000	Day of: Week	Year	Julian Date -2,453,000
1	Fri	182	552.5	Mon	213	583.5	Thu	244	614.5	Sat	274	644.5	Tue	305	675.5	Thu	335	705.5
2	Sat	183	553.5	Tue	214	584.5	Fri	245	615.5	Sun	275	645.5	Wed	306	676.5	Fri	336	706.5
3	Sun	184	554.5	Wed	215	585.5	Sat	246	616.5	Mon	276	646.5	Thu	307	677.5	Sat	337	707.5
4	Mon	185	555.5	Thu	216	586.5	Sun	247	617.5	Tue	277	647.5	Fri	308	678.5	Sun	338	708.5
5	Tue	186	556.5	Fri	217	587.5	Mon	248	618.5	Wed	278	648.5	Sat	309	679.5	Mon	339	709.5
6	Wed	187	557.5	Sat	218	588.5	Tue	249	619.5	Thu	279	649.5	Sun	310	680.5	Tue	340	710.5
7	Thu	188	558.5	Sun	219	589.5	Wed	250	620.5	Fri	280	650.5	Mon	311	681.5	Wed	341	711.5
8	Fri	189	559.5	Mon	220	590.5	Thu	251	621.5	Sat	281	651.5	Tue	312	682.5	Thu	342	712.5
9	Sat	190	560.5	Tue	221	591.5	Fri	252	622.5	Sun	282	652.5	Wed	313	683.5	Fri	343	713.5
10	Sun	191	561.5	Wed	222	592.5	Sat	253	623.5	Mon	283	653.5	Thu	314	684.5	Sat	344	714.5
11	Mon	192	562.5	Thu	223	593.5	Sun	254	624.5	Tue	284	654.5	Fri	315	685.5	Sun	345	715.5
12	Tue	193	563.5	Fri	224	594.5	Mon	255	625.5	Wed	285	655.5	Sat	316	686.5	Mon	346	716.5
13	Wed	194	564.5	Sat	225	595.5	Tue	256	626.5	Thu	286	656.5	Sun	317	687.5	Tue	347	717.5
14	Thu	195	565.5	Sun	226	596.5	Wed	257	627.5	Fri	287	657.5	Mon	318	688.5	Wed	348	718.5
15	Fri	196	566.5	Mon	227	597.5	Thu	258	628.5	Sat	288	658.5	Tue	319	689.5	Thu	349	719.5
16	Sat	197	567.5	Tue	228	598.5	Fri	259	629.5	Sun	289	659.5	Wed	320	690.5	Fri	350	720.5
17	Sun	198	568.5	Wed	229	599.5	Sat	260	630.5	Mon	290	660.5	Thu	321	691.5	Sat	351	721.5
18	Mon	199	569.5	Thu	230	600.5	Sun	261	631.5	Tue	291	661.5	Fri	322	692.5	Sun	352	722.5
19	Tue	200	570.5	Fri	231	601.5	Mon	262	632.5	Wed	292	662.5	Sat	323	693.5	Mon	353	723.5
20	Wed	201	571.5	Sat	232	602.5	Tue	263	633.5	Thu	293	663.5	Sun	324	694.5	Tue	354	724.5
21	Thu	202	572.5	Sun	233	603.5	Wed	264	634.5	Fri	294	664.5	Mon	325	695.5	Wed	355	725.5
22	Fri	203	573.5	Mon	234	604.5	Thu	265	635.5	Sat	295	665.5	Tue	326	696.5	Thu	356	726.5
23	Sat	204	574.5	Tue	235	605.5	Fri	266	636.5	Sun	296	666.5	Wed	327	697.5	Fri	357	727.5
24	Sun	205	575.5	Wed	236	606.5	Sat	267	637.5	Mon	297	667.5	Thu	328	698.5	Sat	358	728.5
25	Mon	206	576.5	Thu	237	607.5	Sun	268	638.5	Tue	298	668.5	Fri	329	699.5	Sun	359	729.5
26	Tue	207	577.5	Fri	238	608.5	Mon	269	639.5	Wed	299	669.5	Sat	330	700.5	Mon	360	730.5
27	Wed	208	578.5	Sat	239	609.5	Tue	270	640.5	Thu	300	670.5	Sun	331	701.5	Tue	361	731.5
28	Thu	209	579.5	Sun	240	610.5	Wed	271	641.5	Fri	301	671.5	Mon	332	702.5	Wed	362	732.5
29	Fri	210	580.5	Mon	241	611.5	Thu	272	642.5	Sat	302	672.5	Tue	333	703.5	Thu	363	733.5
30	Sat	211	581.5	Tue	242	612.5	Fri	273	643.5	Sun	303	673.5	Wed	334	704.5	Fri	364	734.5
31	Sun	212	582.5	Wed	243	613.5				Mon	304	674.5				Sat	365	735.5

CHRONOLOGICAL CYCLES (2005)

Dominical Letter	B	A letter that corresponds to the day upon which the first Sunday (and every subsequent Sunday) of the year falls. For example, A=Sunday Jan 1st, B=Sunday Jan 2nd, C= Sunday Jan 3rd etc. This system was developed in Roman times and is used in constructing the ecclesiastical calendar for any year.
Epact	19	The 'age' of the Moon, the number of days since new moon, diminished by one day, on January 1 in the Gregorian ecclesiastical lunar cycles.
Golden Number (Lunar Cycle)	XI	Year within a 19-year cycle after which moon phases repeat (approximately) on the same calendar day.
Julian Period (year of)	6718	Number of Julian years from Julian Day 0.
Roman Indiction	13	Year within a 15-year cycle based on a Roman taxation cycle. (This, in turn, was based on the maximum length of Roman military service, at the end of which taxation had to be finalised.)
Solar Cycle	26	Year within a 28-year cycle after which weekdays and calendar dates repeat in the Julian Calendar.

ERAS (2005)

ERA NAME	YEAR	BEGINS
Byzantine	7514	Sep 14
Chinese (Gui-Weu)	(4642)	Feb 9
Diocletian	1722	Sep 11
Grecian (Seleucidae)	2317	Sep 14 (or Oct 14)
GREGORIAN	**2005**	**Jan 1**
Indian (Saka)	1927	Mar 22
Islamic (Hegira)*	1426	Feb 9
Japanese	2665	Jan 1
Jewish (A.M)*	5766	Oct 3
Nabonassar	2754	Apr 22
Roman (A.U.C.)	2758	Jan 14

* Year begins at sunset.

All dates are given in terms of the Gregorian calendar in which 2005 January 14 corresponds to 2005 January 1 of the Julian Calendar.

RELIGIOUS CALENDAR (2005)

EVENT	DATE
Epiphany	Jan 6
Ash Wednesday	Feb 9
Islamic New Year (tabular)	Feb 10
Palm Sunday	Mar 20
Good Friday	Mar 25
Easter Day	Mar 27
First Day of Passover (Pesach)	Apr 24
Ascension Day	May 5
Whit Sunday – Pentecost	May 15
Trinity Sunday	May 22
Feast of Weeks (Shavuot)	Jun 13
First Day of Ramadan (tabular)	Oct 4
Jewish New Year (tabular) (Rosh Hashanah)	Oct 4
Day of Atonement (Yom Kippur)	Oct 13
First Day of Tabernacles (Succoth)	Oct 18
First Sunday in Advent	Nov 27
Christmas Day (Saturday)	Dec 25

The Jewish and Islamic dates above are tabular dates, which begin at sunset on the previous evening and end at sunset on the date tabulated. In practice, the dates of Islamic fasts and festivals are determined by an actual sighting of the appropriate New Moon.

HOURS	01	02	03	04	05	06	07	08	09	10	11	12
FRACTION OF A DAY:	0.042	0.083	0.125	0.167	0.208	0.250	0.292	0.333	0.375	0.417	0.458	0.500

HOURS	13	14	15	16	17	18	19	20	21	22	23	24
FRACTION OF A DAY:	0.542	0.583	0.625	0.667	0.708	0.750	0.792	0.833	0.875	0.917	0.958	1.000

Rise Set Corrections

Most of the rise and set times quoted in this Almanac are correct for WA's population centre and state capital, Perth. The maps provided here will assist in the process of making corrections for observations at other locations around the state.

Meteorological and local topography affect the actual time of an object's rise or set. These affects vary from place to place and in general add an uncertainty of about two minutes to these times.

How to make a correction

1. Find the relevant rise or set time at Perth for the date you require,
2. Find the declination of the object on that date,
3. Fnd the rise or set map for the object's declination, or the two maps that bracket the declination, and
4. Estimate your location on the maps,
5. Estimate the correction from the map, or maps.
6. If you use two maps you will need to estimate the correction for both maps, then interpolate (estimate an intermediate value given the objects declination as a proportion between the map declinations) between these two values to obtain the overall correction.

An example:

Sunrise time at Leonora on 2005 Dec 22nd (the December Solstice of 2005).

1 The sunrise time at Perth on that date is 0508 WAST (from December Sun and Moon rise and set table, see section: *December*).

2. The declination of the Sun on that date is -23° 26′ 18″ = -(23+26/60+18/3600)° = -23.°44 (from Sun position table, section: *Solar System Information*).

3. Leonora is approximately NW of the line joining Kalgoorlie and Laverton, or, latitude = -28.9 degrees and longitude = 121.33 degrees E.

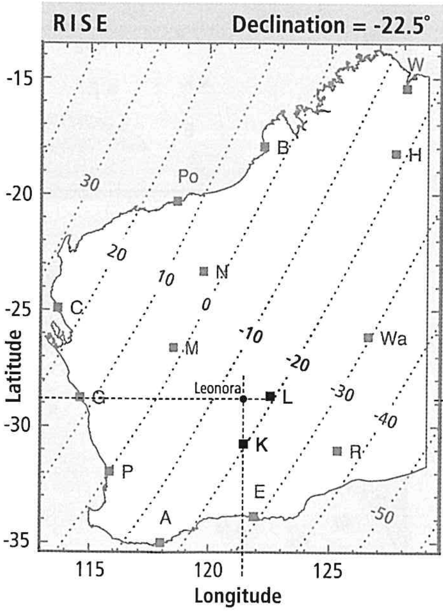
4. Use the rise maps, with declinations –22.°5 and –30.°0. From the rise correction maps the corrections are –16 minutes and –13 minutes, respectively.

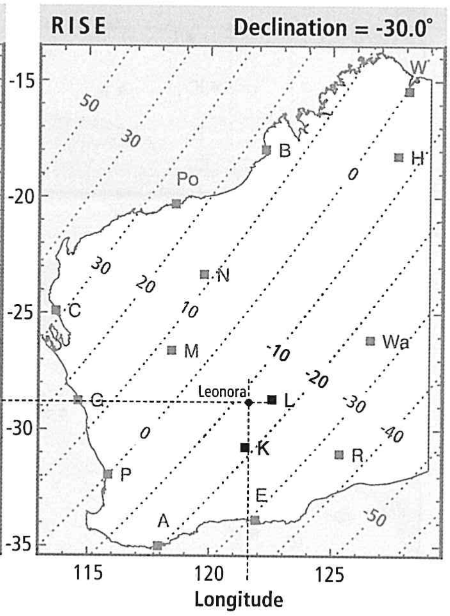
5. Interpolate between maps: -23.°44 is 0.°94 from –22.°5 toward –30.°0. So we must add 0.94/7.5 of the difference between the estimates, from the estimate at –22.°5.

   The interpolation 'correction' = 0.94/7.5 * (-13+16) minutes, is approximately 0 minutes (any fraction of 2 minutes is negligible for these purposes).

   Total correction is –16 minutes (at declination = –22.°5) + interpolation (=0 minutes) = -16 minutes.

Sunrise time at Leonora
= Sunrise time at Perth + correction = 0508 WAST –16 minutes = 0452 WAST.





Notes for maps

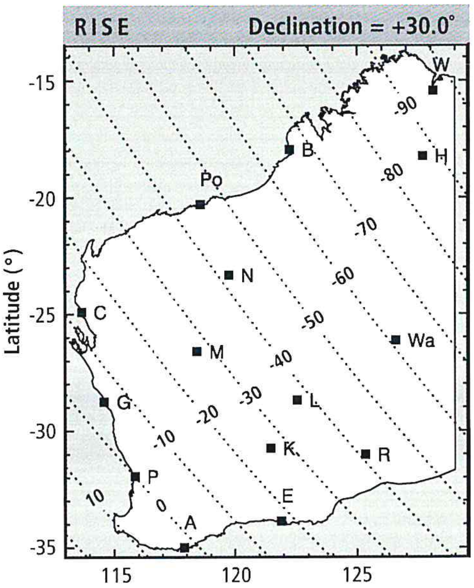
All corrections are the number of minutes to be added to the rise or set time at Perth. The cities and towns indicated are:

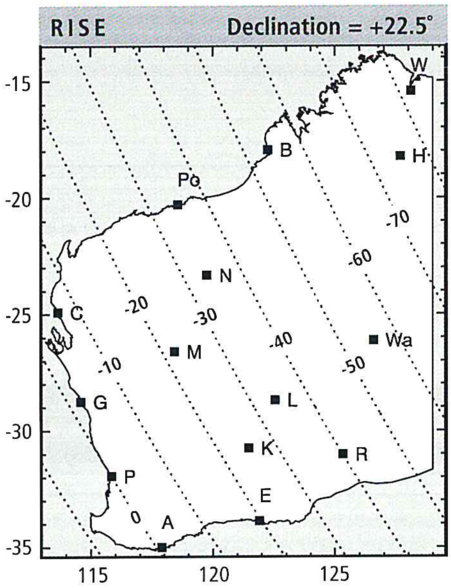
A	**Albany**	B	**Broome**	C	**Carnarvon**	E	**Esperance**
G	**Geraldton**	H	**Halls Creek**	K	**Kalgoorlie**	L	**Laverton**
M	**Meekatharra**	N	**Newman**	P	**Perth**	Po	**Port Hedland**
R	**Rawlinna**	Wa	**Warburton Community**			W	**Wyndham**

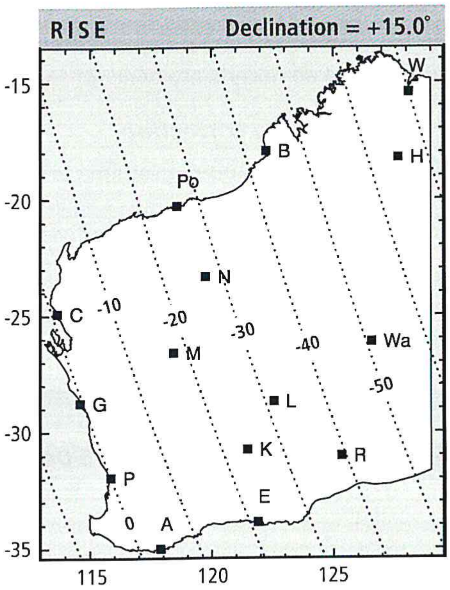
COORDINATES AROUND WA

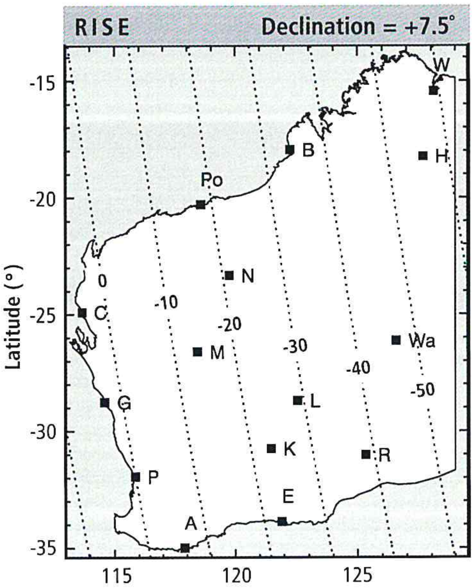
LOCATION	Latitude (° South)	Longitude (° East)
Albany	35.018	117.884
Augusta	34.312	115.159
Bickley (Perth Observatory)	32.017	116.133
Bridgetown	33.958	116.141
Broome	17.962	122.236
Bunbury	33.340	115.642
Carnarvon	24.890	113.660
Christmas Island	10.483	105.623
Cocos (Keeling) Islands	12.166	96.823
Denmark	34.972	117.357
Derby	17.303	123.629
Esperance	33.866	121.888
Eucla	31.675	128.883
Fitzroy Crossing	18.178	125.591
Fremantle	32.056	115.746
Geraldton	28.779	114.614
Giles Meteorological Station	18.227	127.668
Joondalup	31.745	115.766
Kalgoorlie	30.749	121.466
Karratha	20.731	116.857
Kellerberrin	31.632	117.708
Kojonup	33.838	117.152
Lake Grace	33.089	118.405
Laverton	28.623	122.401
Mandurah	32.529	115.723
Marble Bar	21.172	119.746
Meekatharra	26.591	118.497
Moora	30.638	116.010
Mount Magnet	28.062	117.848
Narrogin	32.936	117.178
Newman	23.358	119.730
Norseman	32.196	121.778
Northam	31.647	116.669
Onslow	21.688	115.135
Pemberton	34.446	116.036
Perth	31.952	115.859
Port Hedland	20.310	118.601
Rawlinna	30.776	125.440
Rockingham	32.281	115.727
Southern Cross	31.227	119.327
Tom Price	22.694	117.793
Warburton Community	26.132	126.571
Wiluna	26.595	120.225
Wyndham	15.486	128.120
Yampi Sound	16.129	123.656

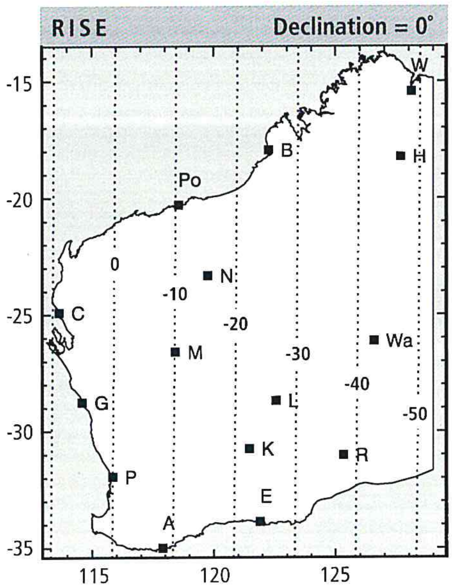
RISE/SET CORRECTION DIAGRAMS FOR WESTERN AUSTRALIA

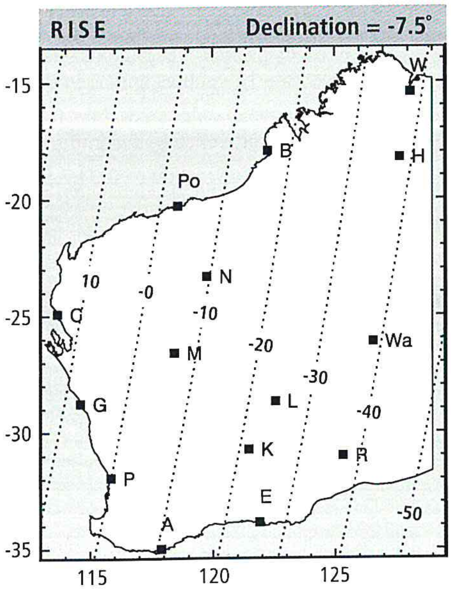

RISE Declination = +30.0°

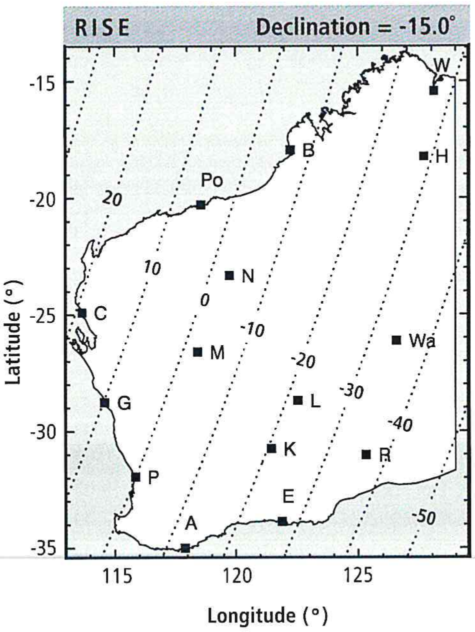

RISE Declination = +22.5°

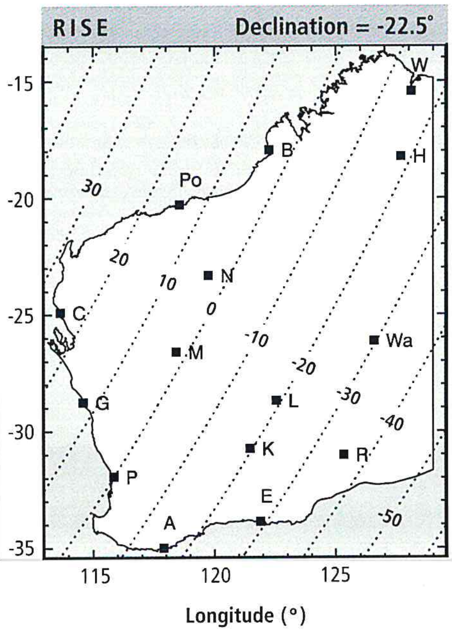

RISE Declination = +15.0°

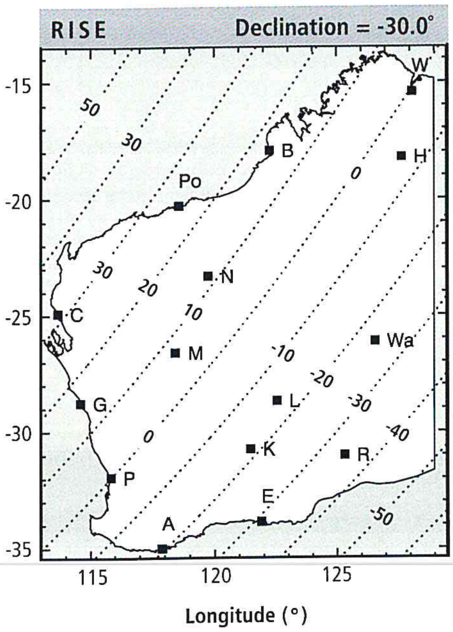

RISE Declination = +7.5°

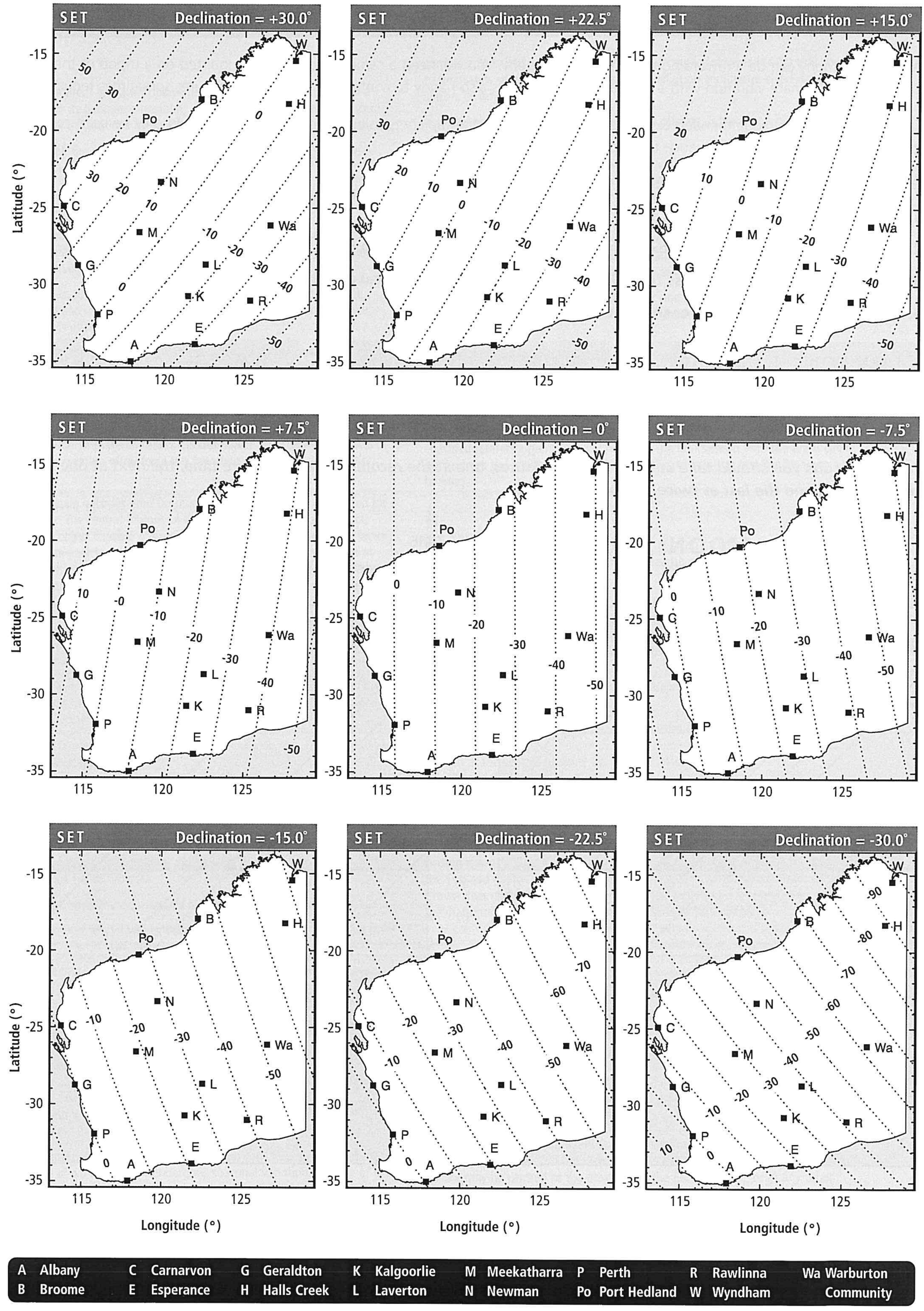

RISE Declination = 0°


RISE Declination = -7.5°


RISE Declination = -15.0°


RISE Declination = -22.5°


RISE Declination = -30.0°


SET Declination = +30.0°
SET Declination = +22.5°
SET Declination = +15.0°
SET Declination = +7.5°
SET Declination = 0°
SET Declination = -7.5°
SET Declination = -15.0°
SET Declination = -22.5°
SET Declination = -30.0°
Latitude (°)
Longitude (°)
-15
-20
-25
-30
-35
115
120
125
W
H
B
Po
N
C
M
Wa
G
L
K
R
P
E
A
A Albany
B Broome
C Carnarvon
E Esperance
G Geraldton
H Halls Creek
K Kalgoorlie
L Laverton
M Meekatharra
N Newman
P Perth
Po Port Hedland
R Rawlinna
W Wyndham
Wa Warburton Community

Astrophotography

Astrophotography can be a rewarding and challenging hobby. You will need a camera that is firmly mounted on a tripod or the like. You can also eliminate vibration with a remote switch, which is also handy to control the long time exposures sometimes required.

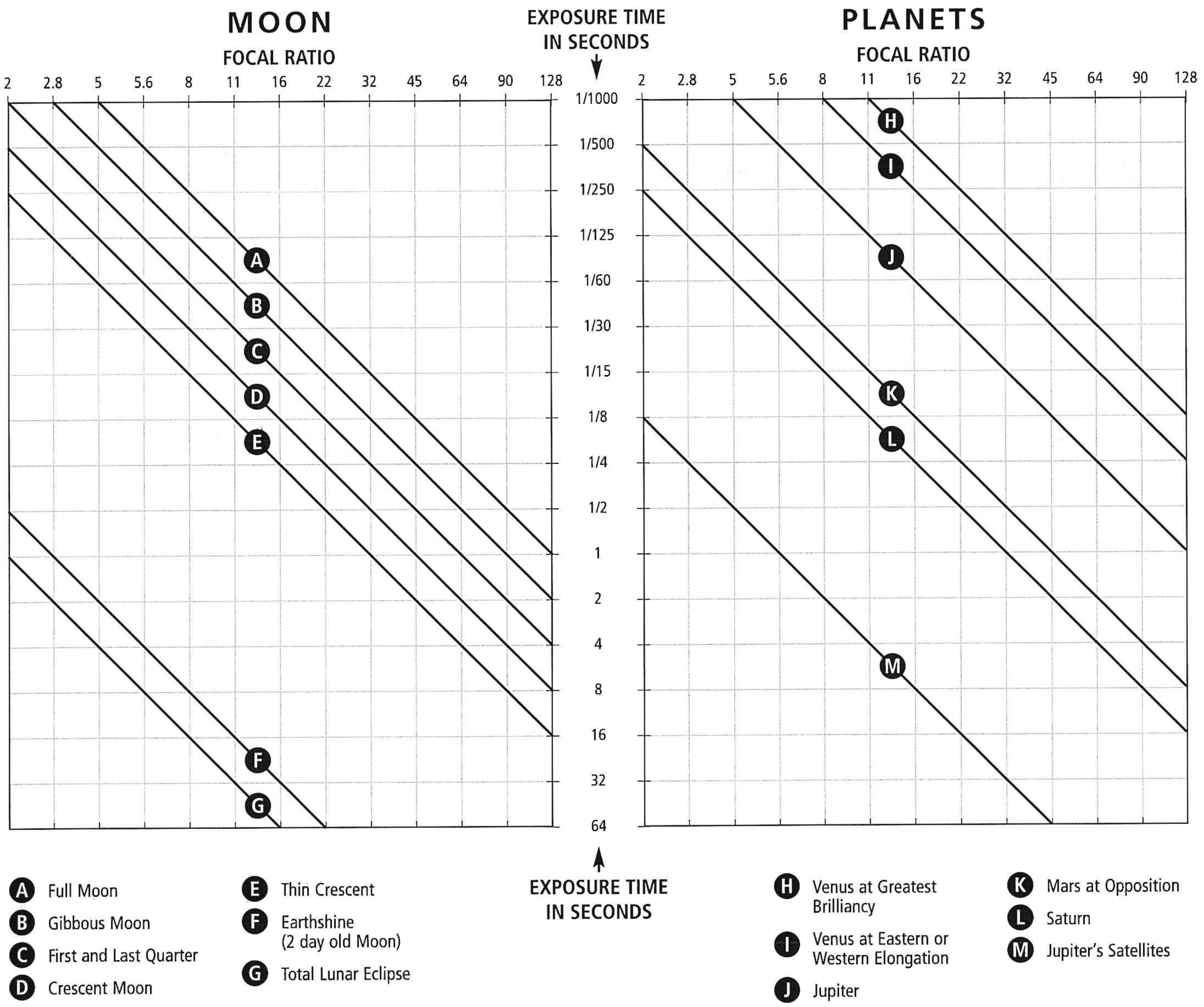
The graphs show the recommended exposure times for the Moon and planets using 100 ISO film. They should only be used as a guide because many factors influence the exposure time.

To select the correct exposure time:

1. **Select your system's focal ratio along the horizontal axis,**
2. **Find the intersection with the exposure line of the Moon or planet required,**
3. **Follow a horizontal line across to find the intersection with the vertical axis for the exposure time, and**
4. **Correct the exposure time for the speed of your film.**

FILM SPEED	MULTIPLY BY	FILM SPEED	DIVIDE BY	FILM SPEED	DIVIDE BY
32 ISO	4	200 ISO	2	800 ISO	8
64 ISO	2	400 ISO	4	1600 ISO	16

For best results you should take at least three exposures, one at the recommended exposure time, the next at one half the exposure, and the last at twice the exposure time.



ASTRONOMY AND ASTROPHYSICS DEFINITIONS

A

aberration: the apparent angular displacement of the observed position of a celestial object from its geometric position, caused by the finite velocity of light in combination with the motions of the observer and of the observed object.

aberration, annual: the component of stellar aberration resulting from the motion of the Earth about the Sun.

aberration, diurnal: the component of stellar aberration resulting from the observer's diurnal motion about the centre of the Earth.

aberration, planetary: the apparent angular displacement of the observed position of a celestial body produced by motion of the observer and the actual motion of the observed object.

aberration, secular: the component of stellar aberration resulting from the essentially uniform and rectilinear motion of the entire Solar System in space. Secular aberration is usually disregarded.

aberration, stellar: the apparent angular displacement of the observed position of a celestial body resulting from the motion of the observer. Stellar aberration is divided into diurnal, annual, and secular components.

accretion, accretion disk: Astronomical objects as diverse as protostars and active galaxies may derive their energy from the gravitational power released by the infall, or accretion, of material onto a central object. The combined effects of gravity, friction and rotation often force the accreting material into an orbiting accretion disk.

active galaxy: Certain galaxies emit far more energy than can be accounted for by their stars alone. The central regions of these galaxies harbour a compact, solar-system-sized object capable of outshining the rest of the galaxy by a factor of 100. The ultimate energy source for active galaxies may be the accretion of matter onto a supermassive black hole. Active galaxies can emit strongly across the entire electromagnetic spectrum, from radio waves to gamma rays. See quasar.

active optics: A technique to reduce the effects of slowly varying forces, such as gravitational deflections and temperature drifts, that can distort a mirror on time scales of minutes to hours, resulting in imperfect images.

adaptive optics: A set of techniques to adjust the mirrors of telescopes on time scales of hundredths of a second to correct for distortions in astronomical images due to turbulence in Earth's atmosphere.

arcminute: A unit of angle corresponding to 1/60th of a degree. The full moon is 30 arcminutes in diameter.

arcsecond: A unit of angle corresponding to 1/3600th of a degree; 1/60th of an arcminute. An arcsecond is approximately the size of a five cent coin viewed from a distance of 1 kilometre.

altitude: the angular distance of a celestial body above or below the horizon, measured along the great circle passing through the body and the zenith. Altitude is 90° minus zenith distance.

anomaly: angular measurement of a body in its orbit from its perihelion.

aphelion: the point in a planetary orbit that is at the greatest distance from the Sun.

apogee: the point at which a body in orbit around the Earth reaches its farthest distance from the Earth. Apogee is sometimes used with reference to the apparent orbit of the Sun around the Earth.

apparent place: the position on a celestial sphere, centred at the Earth, determined by removing from the directly observed position of a celestial body the effects that depend on the topocentric location of the observer; i.e., refraction, diurnal aberration and geocentric (diurnal) parallax. Thus, the position at which the object would actually be seen from the centre of the Earth, displaced by planetary aberration (except the diurnal part and referred to the true equator and equinox.

apparent solar time: the measure of time based on the diurnal motion of the true Sun. The rate of diurnal motion undergoes seasonal variation because of the obliquity of the ecliptic and because of the eccentricity of the Earth's orbit. Additional small variations result from irregularities in the rotation of the Earth on its axis.

array: There are two examples of arrays in common use in astronomy:
(1) A group, or array, of telescopes can be combined to simulate a single large telescope, kilometres or even thousands of kilometres across.
(2) Astronomical instruments have recently been fabricated using new electronic components called detector arrays or charge-coupled devices (CCDs) that consist of thousands of individual detectors constructed on centimetre-sized wafers of silicon, or other materials.

aspect: the apparent position of any of the planets or the Moon relative to the Sun, as seen from Earth.

astrometric ephemeris: an ephemeris of a solar system body in which the tabulated positions are essentially comparable to catalogue mean places of stars at a standard epoch.

astrometry: The branch of astronomy concerned with measuring the positions of celestial objects. Advances in technology may soon permit a 1,000-fold improvement in the measurement of positions, and thus in astronomers' ability to determine distances to stars and galaxies. See parallax.

astronomical co-ordinates: the longitude and latitude of a point on Earth relative to the geoid. These co-ordinates are influenced by local gravity anomalies.

astronomical unit (a.u.): the radius of a circular orbit in which a body of negligible mass, and free of perturbations, would revolve around the Sun in $2\pi/k$ days, where k is the Gaussian gravitational constant. This is slightly less than the semimajor axis of the Earth's orbit. Its value is approximately 1.496×10^8 km.

azimuth: the angular distance measured clockwise along the horizon from a specified reference point (usually north) to the intersection with the great circle drawn from the zenith through a body on the celestial sphere. Similar to compass bearing.

B

baseline: The separation between telescopes in an interferometer. The largest baseline determines the finest detail that can be discerned with an interferometer.

Big Bang: Most astronomers believe that the universe began in a giant explosion called the Big Bang about 14 billion years ago. Starting from an initial state of extremely high density, the universe has been expanding and cooling ever since. Some of the most fundamental observed properties of the universe, including the abundance of light elements such as helium and lithium and the recession of galaxies, can be accounted for by modern theories of the Big Bang.

black hole: A region in space where the density of matter is so extreme, and the resultant pull of gravity so strong, that not even light can escape. Black holes are probably the end point in the evolution of some types of stars and are probably located at the centres of some active galaxies and quasars.

blackbody radiation: A glowing object emits radiation in a quantity and at wavelengths that depend on the temperature of the object. For example, a poker placed in a hot fire first glows red-hot, then yellow-hot, then finally white-hot. This radiation is called thermal or blackbody radiation.

brown dwarf: A star-like object that contains less than about 0.08 the mass of the Sun and is thus too small to ignite nuclear fuels and become a normal star. Brown dwarfs emit small amounts of infrared radiation due to the slow release of gravitational energy and may be a component of dark matter.

C

calendar: a system of reckoning time in which days are enumerated according to their position in cyclic patterns.

Catalogue Equinox: the intersection of the hour circle of zero right ascension of a star catalogue with the celestial equator.

Celestial Equator: the projection onto the celestial sphere of the Earth's equator.

Celestial Pole: either of the two points projected onto the celestial sphere by the extension of the Earth's axis of rotation to infinity.

celestial sphere: an imaginary sphere of arbitrary radius upon which celestial bodies may be considered to be located. As circumstances require, the celestial sphere may be centred at the observer, at the Earth's centre, or at any other location.

charge-coupled device, or CCD: An electronic detector used for lowlight-level imaging and astronomical observations. CCDs were developed by NASA for use in the Hubble Space Telescope and the Galileo probe to Jupiter and are now widely used on ground-based telescopes. See also array.

conjunction: the phenomenon in which two bodies have the same apparent celestial longitude or right ascension as viewed from a third body. Conjunctions are usually tabulated as geocentric phenomena. For Mercury and Venus, geocentric inferior conjunction occurs when the planet is between the Earth and Sun, and superior conjunction occurs when the Sun is between the planet and Earth.

constellation: a grouping of stars, usually with pictorial or mythical associations, that serves to identify an area of the celestial sphere. Also, one of the precisely defined areas of the celestial sphere, associated with a grouping of stars, that the International Astronomical Union has designated as a constellation,

co-ordinated Universal Time (UTC): the time scale available from broadcast time signals. UTC differs from TAI (see International Atomic Time) by an integral number of seconds; it is maintained within ±0.90 second of UTI (see Universal Time) by the introduction of one second steps (leap seconds).

cosmic microwave background (CMB) radiation: The radiation left over from the Big Bang explosion at the beginning of the universe. As the universe expanded, the temperature of the fireball cooled to its present level of 2.7 degrees above absolute zero (2.7 K). Blackbody radiation from the cosmic background is observed at radio, millimetre, and submillimetre wavelengths.

cosmic rays: Protons and nuclei of heavy atoms that are accelerated to high energies in the magnetic field of our galaxy and that can be studied directly from Earth or from satellites.

culmination: passage of a celestial object across the observer's meridian; also called meridian passage. More precisely, culmination is the passage through the point of greatest altitude in the diurnal path. Upper culmination (also called "culmination above pole" for circumpolar stars and the Moon) or transit is the crossing closer to the observer's zenith. Lower culmination (also called "culmination below pole" for circumpolar stars and the Moon) is the crossing farther from the zenith.

D

dark energy: An as yet unknown form of energy that pervades the universe. Its presence was inferred from the discovery that the expansion of the universe is accelerating, and these observations suggest that about 70 percent of the total density of matter plus energy is in this form. Such an acceleration is predicted if the cosmological constant that Einstein included in his General Theory of Relativity were non-zero.

dark matter: Approximately 80 percent of the matter in the universe may so far have escaped direct detection. The presence of this unseen matter has been inferred from motions of stars and gas in galaxies, and of galaxies in clusters of galaxies. Candidates for the missing mass include brown dwarf stars and exotic subatomic particles. Dark matter was called "missing mass" for many years. However, because it is the light, not the mass, that is missing, astronomers have given up this terminology.

day: an interval of 86,400 SI seconds (see second, Systeme International), unless otherwise indicated.

declination: angular distance on the celestial sphere north or south of the celestial equator. It is measured along the hour circle passing through the celestial object. Declination is usually given in combination with right ascension or hour angle. It can be considered the celestial analogue of latitude on Earth.

diffraction limit: The finest detail that can be discerned with a telescope. The physical principle of diffraction limits this level of detail to a value proportional to the wavelength of the light observed divided by the diameter of the telescope.

direct motion: for orbital motion in the solar system, motion that is counter clockwise in the orbit as seen from the north pole of the ecliptic; for an object observed on the celestial sphere, motion that is from west to east, resulting from the relative motion of the object and the Earth.

diurnal motion: the apparent daily motion caused by the Earth's rotation, of celestial bodies across the sky from east to west.

Dynamical Time: the family of time scales introduced in 1984 to replace ephemeris time as the independent argument of dynamical theories and ephemerides.

E

eccentricity: a parameter (usually for orbits) that specifies the extent to which an ellipse departs from circularity. For a circle, eccentricity = 0. Most of the planets and their satellites have low eccentricity. Many comets, and some asteroids and planetary satellites have very eccentric orbits, with eccentricity approaching 1.

eclipse: the obscuration of a celestial body caused by its passage through the shadow cast by another body.

eclipse, annular: a solar eclipse (see eclipse, solar) in which the solar disk is never completely covered but is seen as an annulus or ring at maximum eclipse. An annular eclipse occurs when the apparent disk of the Moon is smaller than that of the Sun.

eclipse, lunar: an eclipse in which the Moon passes through the shadow cast by the Earth. The eclipse may be total (the Moon passing completely through the Earth's umbra), partial (the Moon passing partially through the Earth's umbra at maximum eclipse), or intersectic penumbral (the Moon passing only through the Earth's penumbra).

eclipse, solar: an eclipse in which the Earth passes through the shadow cast by the Moon. It may be total (observer in the Moon's umbra), partial (observer in the Moon's penumbra), or annular.

ecliptic: the mean plane of the Earth's orbit around the Sun. It is also the path of the Sun against the background stars.

elements, orbital: parameters that specify the position and motion of a body in orbit.

electromagnetic spectrum: Radiation can be represented as electric and magnetic fields vibrating with a characteristic wavelength or frequency. Long wavelengths (low frequencies) correspond to radio radiation; intermediate wavelengths, to millimetre and infra-red radiation; short wavelengths (high frequencies), to visible and ultraviolet light; and extremely short wavelengths, to x-rays and gamma rays. Most astronomical observations measure some form of electromagnetic radiation.

elongation, greatest: the instants when the geocentric angular distances of Mercury and Venus from the Sun are at a maximum.

elongation (planetary): the geocentric angle between a planet and the Sun, measured in the plane of the planet, Earth and Sun. Planetary elongations are measured from 0° to 180° east or west of the Sun.

elongation (satellite): the geocentric angle between a satellite and its primary, measured in the plane of the satellite, planet and Earth. Satellite elongations are measured from 0° east or west of the planet.

ephemeris: a tabulation of the positions of a celestial object in an orderly sequence for a number of dates.

Ephemeris Time (ET): the time scale used prior to 1984 as the independent variable in gravitational theories of the solar system. In 1984, ET was replaced by dynamical time.

epoch: an arbitrary fixed instant of time or date used as a chronological reference point for calendars (see calendar), celestial reference systems, star catalogues, or orbital motions.

equation of time: the hour angle of the true Sun minus the hour angle of the fictitious mean sun; alternatively, apparent solar time minus mean solar time.

equator: the great circle on the surface of a body formed by the intersection of the surface with the plane passing through the centre of the body perpendicular to the axis of rotation. (See celestial equator.)

equinox: either of the two points on the celestial sphere at which the ecliptic intersects the celestial equator; also, the time at which the Sun passes through either of these intersection points; i.e., when the apparent longitude of the Sun is 0° or 180°.

era: a system of chronological notation reckoned from a given date.

expansion of the universe: The tendency of every part of the universe to move away from every other part due to the initial impetus of the Big Bang; also known as the Hubble expansion, after the American astronomer Edwin Hubble, whose observations of receding galaxies led to scientists' current understanding of the expanding universe. See redshift.

extragalactic: Objects outside our galaxy, more than about 50,000 light-years away, are referred to as extragalactic.

F

fictitious mean sun: an imaginary body introduced to define mean solar time; essentially the name of a mathematical formula that defined mean solar time. This concept is no longer used in high precision work.

G

galaxy: An isolated grouping of tens to hundreds of billions of stars ranging in size from 5,000 to 150,000 light-years across. Spiral galaxies like our own Milky Way are flattened disks of stars and often contain large amounts of gas out of which new stars can form. Elliptical galaxies are shaped more like footballs and are usually devoid of significant quantities of gas.

gamma-ray astronomy: The study of astronomical objects using the most energetic form of electromagnetic radiation.

gegenschein: faint nebulous light about 20° across near the ecliptic and opposite the Sun, best seen in September and October. Also called counterglow.

General Relativity: Einstein's theory of gravity in which the gravity is the curved geometry of space and time.

geocentric: with reference to, or pertaining to, the centre of the Earth.

geocentric co-ordinates: the latitude and longitude of a point on the Earth's surface relative to the centre of the Earth; also, celestial co-ordinates given with respect to the centre of the Earth.

geoid: an equipotential surface that coincides with mean sea level in the open ocean. On land it is the level surface that would be assumed by water in an imaginary network of frictionless channels connected to the ocean.

geometric position: the geocentric position of an object on the celestial sphere referred to the true equator and equinox, but without the displacement due to planetary aberration.

gravitational lens: A consequence of Einstein's General Relativity Theory is that the path of light rays can be bent by the presence of matter. Astronomers have observed that the light from a distant galaxy or quasar can be 'lensed' by the matter in an intervening galaxy to form multiple and often distorted images of the background object.

Gregorian calendar: the calendar introduced by Pope Gregory XIII in 1582 to replace the Julian calendar; the calendar now used as the civil calendar in most countries. Every year when the end year is exactly divisible by four is a leap year, except for centurial years, which must be exactly divisible by 400 to be leap years. Thus, 2000 is a leap year, but 1900 and 2100 are not leap years.

H

halo (of a galaxy): The roughly spherical distribution of dark matter and thinly scattered stars, star clusters, and gas that surround a spiral galaxy.

height: elevation above ground or distance upwards from a given level (especially sea level) to a fixed point. (See altitude.)

heliocentric: with reference to, or pertaining to, the centre of the Sun.

helioseismology: The study of the internal vibrations of the Sun. In a manner analogous to terrestrial seismology, helioseismology can reveal important information about the Sun's internal condition.

horizon: a plane perpendicular to the line from an observer to the zenith. The great circle formed by the intersection of the celestial sphere with a plane perpendicular to the line from an observer to the zenith is called the astronomical horizon.

horizontal parallax: the difference between the topocentric and geocentric positions of an object, when the object is on the astronomical horizon.

hour angle: angular distance on the celestial sphere measured westward along the celestial equator from the meridian to the hour circle that passes through a celestial object.

hour circle: a great circle on the celestial sphere that passes through the celestial poles and is therefore perpendicular to the celestial equator.

Hubble Space Telescope (HST): A 2.4-m-diameter space telescope designed to study visible, ultraviolet, and infrared radiation; the first of NASA's Great Observatories.

hydrogen: The most abundant element in the universe. It can be observed at a variety of wavelengths, including 21-cm radio, infrared, visible, and ultraviolet wavelengths, and in a variety of forms, including atoms (HI) and molecular (H_2) and ionised (HII) forms.

I

inclination: the angle between two planes or their poles; usually the angle between an orbital plane and a reference plane; one of the standard orbital elements that specifies the orientation of an orbit.

infra-red astronomy: The study of astronomical objects using intermediate-wavelength radiation to which the atmosphere is mostly opaque and the human eye insensitive. Humans sense infra-red energy as heat. The infra-red part of the electromagnetic spectrum generally corresponds to radiation with wavelengths from 1 mm to 1,000 mm. Objects with temperatures around room temperature emit most of their radiation in the infrared.

interferometer, interferometry: A spatial interferometer combines beams of light from different telescopes to synthesise the aperture of a single large telescope; see array. Spatial interferometry is the main technique used by astronomers to map sources at high resolution and to measure their positions with high precision. A different form of interferometer can be used on a single telescope to break up the light into its constituent colours; see spectroscopy.

International Atomic Time (TAI): the continuous scale resulting from analyses by the Bureau International des Poids et Mesures of atomic time standards in many countries. The fundamental unit of TAI is the SI second, and the epoch is 1958 January 1.

invariable plane: the plane through the centre of mass of the Solar System perpendicular to the angular momentum vector of the Solar System.

irradiation: an optical effect of contrast that makes bright objects viewed against a dark background appear to be larger than they really are.

J

Julian calendar: the calendar introduced by Julius Caesar in 46 B.C. to replace the Roman calendar. In the Julian calendar a common year is defined to comprise 365 days, and every fourth year is a leap year comprising 366 days. The Julian calendar was superseded by the Gregorian calendar.

Julian date (JD): the interval of time in days and fraction of a day since 4713 B.C. January 1, Greenwich noon, Julian proleptic calendar. In precise work the timescale, e.g., dynamical time or Universal Time, should be specified. This system facilitates easy calculation of the time interval between two events.

Julian date, modified (MJD): the Julian date minus 2400000.5.

Julian day number: the integral part of the Julian date.

L

latitude, celestial: angular distance on the celestial sphere measured north or south of the ecliptic along the great circle passing through the poles of the ecliptic and the celestial object.

latitude, terrestrial: angular distance on the Earth measured north or south of the equator along the meridian of a geographic location.

leap second: a second added between 60 seconds and 0 seconds at the announced times to keep UTC within 0s.90 of UT1 Generally, leap seconds are added at the end of June or December.

librations: variations in the orientation of the Moon's surface with respect to an observer on the Earth. Physical librations are due to variations in the orientation of the Moon's rotational axis in inertial space. The much larger optical librations are due to variations in the rate of the Moon's orbital motion, the obliquity of the Moon's equator to its orbital plane, and the diurnal changes of geometric perspective of an observer on the Earth's surface.

light-time: the interval of time required for light to travel from a celestial body to the Earth. During this interval the motion of the body in space causes an angular displacement of its apparent place from its geometric place.

light pollution: The emission of stray light or glare from lighting fixtures in manners that counter the purpose of the light (which is to light what is below); also known as the waste of money and energy in the form of electric light, usually meant in the form of outdoor night lighting. Such light trespass can cause severe safety problems for motorists, pedestrians, and cyclists at night from lighting that shines onto streets and highways and footpaths from poorly-designed or poorly-mounted lighting. Such glare also imposes on privacy, by shining brightly into private residences at night and into backyards where adults and children are trying to observe the night sky. It also restricts our view of the night sky – a part of our world's natural and cultural heritage. While most people have accepted bad lighting and glare without question and assumed that nothing could be done about it, dedicated groups of volunteers around the world are now showing that effective laws and guidelines can be instated at the local and regional levels of government (and in planning and engineering offices). This can mean that proper outdoor night lighting can be a norm so that everybody benefits - car drivers, sleeping residents, government budgets, and skygazers alike. Laws limiting light pollution are already in existence in the Czech Republic and certain regions of the USA.

light-year: A unit of astronomical distance equal to the distance light travels in a year: about 10,000,000,000,000 km. The nearest star is 4 light-years away. The center of our galaxy is about 25,000 light-years away. The closest galaxy is about 180,000 light-years away.

limb: the apparent edge of the Sun, Moon, or a planet or any other celestial body with a detectable disk.

local sidereal time: the local hour angle of a catalogue equinox.

longitude, celestial: angular distance on the celestial sphere measured eastward along the ecliptic from the dynamical equinox to the great circle passing through the poles of the ecliptic and the celestial object.

longitude, terrestrial: angular distance measured along the Earth's equator from the Greenwich meridian to the meridian of a geographic location.

luminosity class: distinctions among stars of the same spectral class. (See spectral types or classes).

lunar phases: cyclically recurring apparent forms of the Moon. New moon, first quarter, full moon and last quarter are defined as the times at which the excess of the apparent celestial longitude of the Moon over that of the Sun is 0°, 90°, 180° and 270° respectively.

lunation: the period of time between two consecutive new moons.

M

Magellanic Clouds, Large and Small: Two galaxies close to our own Milky Way, located about 180,000 light-years away and visible only from the Southern Hemisphere. A bright supernova, SN1987A, was observed in the Large Magellanic Cloud in 1987.

magnetohydrodynamics: The study of the motion of gases in the presence of magnetic fields.

magnitude, stellar: a measure on a logarithmic scale of the brightness of a celestial object considered as a point source. Fainter stars have numerically larger magnitudes. The brightest stars, excluding the Sun, are about magnitude 0; the faintest star visible to the unaided eye is about magnitude 6. A star of magnitude 15 is one-millionth as bright as the half dozen brightest stars of magnitude 0. Stars as faint as magnitude 28 can be seen with powerful terrestrial or spacebourne telescopes.

magnitude of a lunar eclipse: the fraction of the lunar diameter obscured by the shadow of the Earth at the greatest phase of a lunar eclipse, measured along the common diameter.

magnitude of a solar eclipse: the fraction of the solar diameter obscured by the Moon at the greatest phase of a solar eclipse, measured along the common diameter.

massive compact halo object (MACHO): An hypothetical object of roughly stellar mass in the halo of our galaxy that is too faint to be detected by its own emission. MACHOs are indirectly detected via gravitational microlensing of more distant stars.

mean anomaly: in undisturbed elliptic motion, the product of the mean motion of an orbiting body and the interval of time since the body passed pericentre. Thus, the mean anomaly is the angle from pericentre of a hypothetical body moving with a constant angular speed that is equal to the mean motion.

mean distance: the semimajor axis of an elliptic orbit.

mean equator and equinox: the celestial reference system determined by ignoring small variations of short period in the motions of the celestial equator. Thus, the mean equator and equinox are affected only by precession. Positions in star catalogues are normally referred to the mean catalogue equator and equinox of a standard epoch.

mean motion: in undisturbed elliptic motion, the constant angular speed required for a body to complete one revolution in an orbit of a specified semimajor axis.

mean place: the geocentric position, referred to the mean equator and equinox of a standard epoch, of an object on the celestial sphere centred at the Sun. A mean place is determined by removing from the directly observed position the effects of refraction, parallax geocentric and stellar parallax, and stellar aberration, and by referring the co-ordinates to the mean equator and equinox of a standard epoch.

mean solar time: a measure of time based conceptually on the diurnal motion of the fictitious mean sun, under the assumption that the Earth's rate of rotation is constant.

meridian: a great circle passing through the celestial poles and through the zenith of any location on Earth. For planetary observations a meridian is half the great circle passing through the planet's poles and through any location on the planet.

microlensing: Gravitational lensing due to a stellar mass object. This lensing phenomenon is called microlensing because the mass of the lens is so small compared with that of a galaxy. Microlensing of distant stars by intervening faint stars can reveal planets in orbit around the lensing star.

Milky Way: Our Sun is located in the Milky Way Galaxy, a spiral galaxy consisting of some 100,000,000,000 stars spread in a disk more than 80,000 light-years across and hundreds of light-years thick. The central disk of the Milky Way is the wide path of faint light that stretches across the night sky.

month: the period of one complete synodic or sidereal revolution of the Moon around the Earth; also, a calendrical unit that approximates the period of revolution.

moonrise, moonset: the times at which the apparent upper limb of the Moon is on the astronomical horizon; i.e., when the true zenith distance, referred to the centre of the Earth, of the central point of the disk is $90° 34' + s - \pi$, where s is the Moon's semi-diameter, π is the horizontal parallax, and 34' is the adopted value of horizontal refraction.

N

nadir: the point on the celestial sphere diametrically opposite to the zenith.

neutrino: One of a family of subatomic particles with little or no mass. These particles are generated in nuclear reactions on Earth, in the centers of stars, and during supernova explosions and can give unique information about these energetic processes. Because neutrinos interact only weakly with matter, they are difficult to detect.

node: either of the points on the celestial sphere at which the plane of an orbit intersects a reference plane. The position of a node is one of the standard orbital elements used to specify the orientation of an orbit.

nucleosynthesis: The process by which heavy elements such as helium, carbon, nitrogen, and iron are formed out of the fusion of lighter elements, such as hydrogen, during the normal evolution of stars, during supernova explosions, and in the Big Bang.

nutation: the short-period oscillations in the motion of the pole of rotation of a freely rotating body that is undergoing torque from external gravitational forces. Nutation of the Earth's pole is discussed in terms of components in obliquity and longitude.

O

obliquity: in general, the angle between the equatorial and orbital planes of a body or, equivalently, between the rotational and orbital poles. For the Earth the obliquity of the ecliptic is the angle between the planes of the equator and the ecliptic.

occultation: the obscuration of one celestial body by another of greater apparent diameter; especially the passage of the Moon in front of a star or planet, or the disappearance of a satellite behind the disk of its primary. If the primary source of illumination of a reflecting body is cut off by the occultation, the phenomenon is also called an eclipse. The occultation of the Sun by the Moon is a solar eclipse.

opposition: a configuration of the Sun, Earth and a planet in which the apparent geocentric longitude of the planet differs by 180° from the apparent geocentric longitude of the Sun.

optical astronomy: The study of astronomical objects using light waves with wavelengths from about 1 to 0.3 μm. The human eye is sensitive to most of these wavelengths. See electromagnetic spectrum.

orbit: the path in space followed by a celestial body.

P

parallax: the difference in apparent direction of an object as seen from two different locations; conversely, the angle at the object that is subtended by the line joining two designated points. Geocentric (diurnal) parallax is the difference in direction between a topocentric observation and a hypothetical geocentric observation. Heliocentric or annual parallax is the difference between hypothetical geocentric and heliocentric observations; it is the angle subtended at the observed object by the semimajor axis of the Earth's orbit.

parsec: the distance at which one astronomical unit subtends an angle of one second of arc; equivalently, the distance to an object having an annual parallax of one second of arc. Its value is 3.086 x 10^{13} km, or 3.27 light years.

penumbra: the portion of a shadow in which light from an extended source is partially but not completely cut off by an intervening body; the area of partial shadow surrounding the umbra.

pericentre: the point in an orbit that is nearest to the centre of force.

perigee: the point at which a body in orbit around the Earth most closely approaches the Earth. Perigee is sometimes used with reference to the apparent orbit of the Sun around the Earth.

perihelion: the point at which a body in orbit around the Sun most closely approaches the Sun.

period: the interval of time required to complete one revolution in an orbit or one cycle of a periodic phenomenon, such as a cycle of phases.

phase: the ratio of the illuminated area of the apparent disk of a celestial body to the area of the entire apparent disk taken as a circle. For the Moon, phase designations (see lunar phases) are defined by specific configurations of the Sun, Earth and Moon. For eclipses, phase designations (total, partial, penumbral, etc.) provide general descriptions of the phenomena. More generally, for use with oddly shaped bodies, phase might be defined as 0.5(1 + cos (phase angle)).

phase angle: the angle measured at the centre of an illuminated body between the light source and the observer.

photometry: a measurement of the intensity of light usually specified for a specific frequency range.

planetocentric co-ordinates: co-ordinates for general use, where the z-axis is the mean axis of rotation, the x-axis is the intersection of the planetary equator (normal to the z-axis through the centre of mass) and an arbitrary prime meridian, and the y-axis completes a right-hand co-ordinate system. Longitude of a point is measured positive to the prime meridian as defined by rotational elements. Latitude of a point is the angle between the planetary equator and a line to the centre of mass. The radius is measured from the centre of mass to the surface point.

planetographic co-ordinates: co-ordinates for cartographic purposes dependent on an equipotential surface as a reference surface. Longitude of a point is measured in the direction opposite to the rotation (positive to the west for direct rotation) from the cartographic position of the prime meridian defined by a clearly observable surface feature. Latitude of a point is the angle between the planetary equator (normal to the z-axis and through the centre of mass) and normal to the reference surface at the point. The height of a point is specified as the distance above a point with the same longitude and latitude on the reference surface.

polar motion: the irregularly varying motion of the Earth's pole of rotation with respect to the Earth's crust.

precession: the uniformly progressing motion of the pole of rotation of a freely rotating body undergoing torque from external gravitational forces. In the case of the Earth, the component of precession caused by the Sun and Moon acting on the Earth's equatorial bulge is called lunisolar precession; the component caused by the action of the planets is called planetary precession. The sum of lunisolar and planetary precession is called general precession.

proper motion: the projection onto the celestial sphere of the space motion of a star relative to the solar system; thus, the transverse component of the space motion of a star with respect to the solar system. Proper motion is usually tabulated in star catalogues as changes in right ascension and declination per year or century.

protogalaxy: Galaxies are thought to have formed fairly early in the history of the universe, by the collapse of giant clouds of gas. During this process, a first generation of stars formed.

protoplanetary or protostellar disk: A disk of gas and dust surrounding a young star or protostar out of which planets may form.

protostar: The earliest phase in the evolution of a star, in which most of its energy comes from the infall of material, or accretion, onto the growing star. A protostellar disk probably forms around the star at this time.

Q

quadrature: a configuration in which two celestial bodies have apparent longitudes that differ by 90° as viewed from a third body. Quadratures are usually tabulated with respect to the Sun as viewed from the centre of the Earth.

quasar: An extremely compact, luminous source of energy found in the cores of certain galaxies. A quasar may outshine its parent galaxy by a factor of 1,000 yet be no larger than our own solar system. The accretion of gas onto a supermassive black hole probably powers the quasar. Active galaxies are probably less luminous and less distant versions of quasars.

R

radial velocity: the rate of change of the distance to an object.

radio astronomy: The study of astronomical objects using radio waves with wavelengths generally longer than 0.5 to 1 mm. See electromagnetic spectrum.

redshift: Radiation from an approaching object is shifted to higher frequencies (to the blue), while radiation from a receding object is shifted to lower frequencies (to the red). A similar effect raises the pitch of an ambulance siren as it approaches. The expansion of the universe makes objects recede so that the light from distant galaxies is redshifted. The redshift is parameterised by z, where the wavelength shift is given by the factor (1 + z) times the wavelength.

refraction, astronomical: the change in direction of travel (bending) of a light ray as it passes obliquely through the atmosphere. As a result of refraction the observed altitude of a celestial object is greater than its geometric altitude. The amount of refraction depends on the altitude of the object and on atmospheric conditions.

resolution: Spatial resolution describes the ability of an instrument to separate features at small details; see diffraction limit and interferometer.

retrograde motion: for orbital motion in the solar system, motion that is clockwise in the orbit as seen from the north pole of the ecliptic; for an object observed on the celestial sphere, motion that is from east to west, resulting from the relative motion of the object and the Earth.

right ascension: angular distance on the celestial sphere measured eastward along the celestial equator from the equinox to the hour circle passing through the celestial object. Right ascension is usually given in combination with declination. It can be considered the celestial analogue of longitude on Earth.

S

second, Systeme International (SI): the duration of 9,192,631,770 cycles of radiation corresponding to the transition between two hyperfine levels of the ground state of caesium 133.

selenocentric: with reference to, or pertaining to, the centre of the Moon.

semidiameter: the angle at the observer subtended by the equatorial radius of the Sun, Moon or a planet.

semi-major axis: half the length of the major axis of an ellipse; a standard element used to describe an elliptical orbit.

sidereal day: the time interval between two consecutive transits of the catalogue equinox (Right Ascension 0h for a specific catalogue). A slightly inaccurate definition is the time interval between two consecutive transits of a given star.

sidereal hour angle: angular distance on the celestial sphere measured westward along the celestial equator from the catalogue equinox to the hour circle passing through the celestial object. It is equal to 360° minus right ascension in degrees.

sidereal time: the measure of time defined by the apparent diurnal motion of the catalogue equinox; hence, a measure of the rotation of the Earth with respect to the stars rather than the Sun.

solstice: either of the two points on the ecliptic at which the apparent longitude of the Sun is 90° or 270°; also, the time at which the Sun is at either point.

spectral resolution: describes the ability of an instrument to discern small shifts in wavelength; see spectroscopy.

spectroscopy: A technique whereby the light from astronomical objects is broken up into its constituent colours. Radiation from the different chemical elements that make up an object can be distinguished, giving information about the abundances of these elements and their physical state.

spectral types or classes: catagorisation of stars according to their spectra, primarily due to differing temperatures of the stellar atmosphere. From hottest to coolest, the spectral types are 0, B, A, F, G, K and M.

standard epoch: a date and time that specifies the reference system to which celestial co-ordinates are referred. Prior to 1984 co-ordinates of star catalogues were commonly referred to the mean equator and equinox of the beginning of a Besselian year. Beginning with 1984 the Julian year has been used, as denoted by the prefix J, e.g., J2000.0.

starburst galaxy: Certain galaxies, particularly those perturbed by a close encounter or collision with another galaxy, often form stars at a rate hundreds of times greater than that evident in our galaxy. Such galaxies are bright sources of infrared radiation.

stationary point (of a planet): the position at which the rate of change of the apparent right ascension of a planet is momentarily zero.

submillimetre radiation: Electromagnetic radiation with wavelengths between about 0.1 and 1 mm intermediate between radio and infrared radiation.

sunrise, sunset: the times at which the apparent upper limb of the Sun is on the astronomical horizon; i.e., when the true zenith distance, referred to the centre of the Earth, of the central point of the disk is 90° 50′, based on adopted values of 34′ for horizontal refraction and 16′ for the Sun's semidiameter.

Sunyaev-Zeldovich effect: An astrophysical effect whereby the distribution of wavelengths of radiation seen through the gas in a distant cluster of galaxies is subtly modified. Measurement of this effect can be used to determine the distance to the cluster.

supermassive black hole: A black hole that is much more massive than the Sun. Supermassive black holes with masses exceeding a million solar masses are found in the nuclei of most galaxies.

supernova: A star that, due to accretion of matter from a companion star or exhaustion of its own fuel supply, can no longer support itself against its own weight and thus collapses, throwing off its outer layers in a burst of energy that outshines an entire galaxy. In 1987 a star in the Large Magellanic Cloud was observed as a dramatic supernova called Supernova 1987A.

surface brightness (of a planet): the visual magnitude of an average square arc-second area of the illuminated portion of the apparent disk.

synodic period: for planets, the mean interval of time between successive conjunctions of a pair of planets, as observed from the Sun; for satellites, the mean interval between successive conjunctions of a satellite with the Sun, as observed from the satellite's primary.

T

Terrestrial Time (TT): the independent argument for apparent geocentric ephemerides, known in this publication 1984 - 2000 as Terrestrial Dynamical Time (TDT). At 1977 January 1d00h00m00s TAI, the value of TT was exactly 1977 January 1d0003725. The unit of TT is 86 400 SI seconds at mean sea level. For practical purposes TT = TAI + 32s184.

terminator: the boundary between the illuminated and dark areas of the apparent disk of the Moon, a planet or a planetary satellite

topocentric: with reference to, or pertaining to, a point on the surface of the Earth.

transit: the passage of the apparent centre of the disk of a celestial object across a meridian; also, the passage of one celestial body in front of another of greater apparent diameter (e.g., the passage of Mercury or Venus across the Sun or Jupiter's satellites across its disk); however, the passage of the Moon in front of the larger apparent Sun is called an annular eclipse. The passage of a body's shadow across another body is called a shadow transit; however, the passage of the Moon's shadow across the Earth is called a solar eclipse.

true anomaly: the angle, measured at the focus nearest the pericentre of an elliptical orbit, between the pericentre and the radius vector from the focus to the orbiting body; one of the standard orbital elements.

true equator and equinox: the celestial co-ordinate system determined by the instantaneous positions of the celestial equator and ecliptic. The motion of this system is due to the progressive effect of precession and the short-term, periodic variations of nutation.

twilight: the interval of time preceding sunrise and following sunset (see sunrise, sunset) during which the sky is partially illuminated. Civil twilight comprises the interval when the zenith distance, referred to the centre of the Earth, of the central point of the Sun's disk is between 90° 50′ and 96°, nautical twilight comprises the interval from 96° to 102°, and astronomical twilight comprises the interval from 102° to 108°.

U

ultraviolet astronomy: The study of astronomical objects using short-wavelength radiation, from 0.3 mm to 0.01 mm (10 nm), to which the atmosphere is opaque and the human eye insensitive. See electromagnetic spectrum.

umbra: the portion of a shadow cone in which none of the light from an extended light source (ignoring refraction) can be observed.

Universal Time (UT): a measure of time that conforms, within a close approximation, to the mean diurnal motion of the Sun and serves as the basis of all civil timekeeping. UT is formally defined by a mathematical formula as a function of sidereal time. Thus, UT is determined from observations of the diurnal motions of the stars. The time scale is determined directly from such observations is designated UT0; it is slightly dependent on the place of observation. When UT0 is corrected for the shift in longitude of the observing station caused by polar motion, the time scale UT1 is obtained. Whenever the designation UT is used in this volume, UT1 is implied.

V

vernal equinox: the ascending node of the ecliptic on the celestial sphere; also, the time at which the apparent longitude of the Sun is 0°.

vertical: the apparent direction of gravity at the point of observation (normal to the plane of a free level surface).

W

week: an arbitrary period of days, usually seven days; approximately equal to the number of days counted between the four phases of the Moon.

X

x-ray astronomy: The study of astronomical objects using x-rays with wavelengths shorter than about 10 nm, to which the atmosphere is opaque. X-rays are emitted by extremely energetic objects that have temperatures of millions of degrees. See electromagnetic spectrum.

Y

year: a period of time based on the orbit of the Earth around the Sun. The calendar year (see Gregorian calendar) is an approximation to the tropical year. The anomalistic year is the mean interval between successive passages of the Earth through perihelion. The sidereal year is the mean period of revolution with respect to the background stars.

year, tropical: the period of one complete revolution of the mean longitude of the Sun with respect to the dynamical equinox.

Z

zenith: in general, the point directly overhead on the celestial sphere. The astronomical zenith is the extension to infinity of a plumb line. The geocentric zenith is defined by the line from the centre of the Earth through the observer. The geodetic zenith is the normal to the geodetic ellipsoid at the observer's location.

zenith distance: angular distance on the celestial sphere measured along the great circle from the zenith to the celestial object. Zenith distance is 90° minus altitude.

zodiacal light: a nebulous light seen in the cast before twilight and in the west after twilight. It is triangular in shape along the ecliptic with the base on the horizon and its apex at varying altitudes. It is best seen in middle latitudes on spring evenings and autumn mornings.

What was that?

Attention seekers in the night sky

One of the ways Perth Observatory serves the taxpayers of Western Australia is by answering enquiries from the public. A lot of these involve interpreting people's naked-eye observations of something in the sky. Hopefully, reading this section will stimulate an awareness of what is visible in the night sky as well facilitating an increase in observing skills so that anyone can make scientifically meaningful observations. More details concerning some of the objects discussed here, and their visibility, can be found elsewhere in this Almanac.

Most careful and detailed observations of apparently unusual objects are explicable by known phenomena. When given thorough (but time consuming) examination, less than 2% of allegedly unusual observations remain "unidentified". Just because they are unidentified does not mean they are evidence of extraterrestrials, or their technology! The late Professor Carl Sagan once said, "extraordinary claims require extraordinary evidence".

The following objects are the subject of most enquiries.

Venus

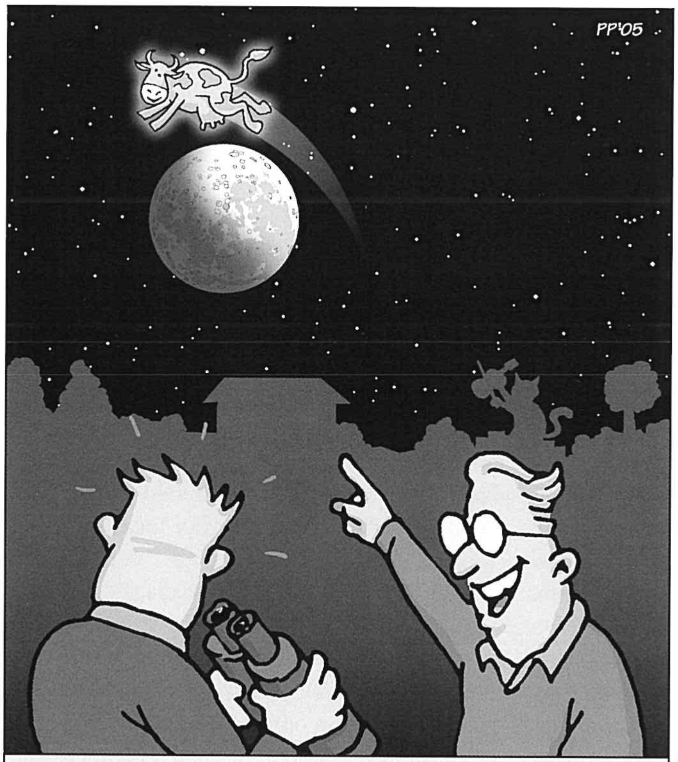
Venus is the brightest star-like object in the sky. It can appear as an 'evening star' as well as a 'morning star' – it just depends on its and Earth's positions in their respective orbits around the Sun. Venus orbits closer to the Sun than Earth, so it is only visible up to about three hours after sunset or before sunrise – it can never be visible around midnight (except in polar regions). Consult the monthly sections for information on the visibility of this planet (and other planets).

Shooting stars or meteors

Shooting stars are the glow of energy released as small particles about the size of a grain of sand "crash" into Earth's upper atmosphere. Very bright meteors are called fireballs or bolides. Sometimes they are so bright they can even be observed in the daytime, and sometimes a sonic boom can be heard as they break the sound barrier when they plough through the atmosphere. At certain times of the year the Earth passes through a cloud of comet debris and the number of meteors substantially increases (see meteor showers in the *Solar System Information* Section). Some meteors are the debris from collisions between asteroids.

Satellites

Satellites are generally visible for a few hours after sunset and a few hours before sunrise as they reflect sunlight off their highly reflective outer surfaces. Around midnight low-Earth orbiting satellites (the majority) are not visible because they are in Earth's shadow. Most satellites are launched in a roughly West to East orbit as this has the lowest fuel requirements. This is also the trajectory of most of the space junk that glows on re-entry into the atmosphere. **Space junk** re-entries have orbits essentially parallel with the ground so they last for a longer duration and can be viewed along a long path across the Earth. Weather and reconnaissance satellites can orbit North to South (or vice versa) in order to get a longer duration view of the Earth. **Iridium communication satellites** have one highly reflecting surface and when the geometry is favourable we can observe a slow flash of light that builds up to a maximum in about 5 seconds, and then fades over a similar time. About one of these flashes is visible from any location on the Earth every night, and about once per month a flash about ten times brighter than Venus provides a spectacular sight. Information about the visibility of satellites can be found in the *Astronomy on the Internet* sub-section.



See Jenkins! There it is again! – incredible isn't it! Now if we quickly triangulate, we'll find the source of that infernal music!

Clouds

Clouds can partially obscure the Moon, planets and aircraft thus giving the impression of changing lights or a halo effect. Beams of light moving through the sky, or circles of light on the under side of clouds result from **searchlights** operated on the ground (usually to promote some entertainment activity). High-altitude aircraft can also leave a trail of water vapour called a contrail.

Refraction (the bending of light) through **ice crystals** or **water droplets** high in the atmosphere can create halos and coronae (coloured clouds) near the Sun or Moon.

Pranks

Some people make artificial "UFOs". One of the Observatory staff has actually recovered one after tracking it. Such "UFOs" may have the appearance of either a solitary light, or a string of lights moving in unison across the night sky. This prank can be very dangerous because of the fire and aviation hazards involved.

Recording your observations

A **Sighting Report Form** is provided on the following page, and an explanation of its contents is given in order to assist the recording of scientifically useful observations.

The first thing of note about the Sighting Report Form is its rather non-specific nature. That is, with only minor modification it could be adapted for other uses such as bird watching, rock hunting etc. You are encouraged to modify it for your specific use.

An important point to remember is: ***record your own observations as soon as possible after the event***. Try not to be influenced by those who may have accompanied you. Instead, get them to complete their own Sighting Report Forms. We don't all observe things in the same way, so multiple individual reports of a sighting will provide a more accurate description of the event. Also, try to be objective about your observations. This can be difficult because a spectacular or sudden event can evoke a variety of emotions.

The section concerning the Observer Details is rather obvious, but we do need these should we require to contact you.

The Sighting Details section has many parts, but please try to be brief as well accurate with your report.

The **date** and **time** are important details. Don't forget to look at your watch or a clock as soon as possible after the sighting (this is probably inappropriate during the sighting). Local time (appropriate to your time zone) should be recorded to the nearest minute. Try to be fairly precise with your **location**. It is acceptable to record this in relative terms such as "100 metres west of Fremantle Railway Station", "in my backyard", etc. Observatory staff can always determine the location more accurately later if need be. Also, note the **sky conditions** as best you can. Conditions other than clear, dark skies can really limit the quality of the observation or distort an otherwise commonplace event such as the motion of an aeroplane. Next, record your **method of observation**.

Some sightings are over in an instant, but try to determine the **duration**. It's probably inopportune to look at your watch during a sighting, but you could try to count the seconds using some mental (or voiced) counting method like – "One (thousand and), two (thousand and), three (thousand and) ..." Beware, most people are notoriously unreliable at guessing time intervals after a particularly startling event. Some phenomena have **sound** associated with them so report anything that you hear.

The **trajectory**, or path across the sky, or the location of a stationary event, is important data. The altitude above the horizon and the compass bearing where you first detected the object are the first things to note. The horizon has an altitude of 0 degrees (assuming any surrounding hills and valleys are of insignificant size), while straight overhead (the zenith) is at altitude 90 degrees. One way to estimate altitude is by spreading out your hand and holding it out at arm's length. The span between the tips of your thumb and little finger is approximately 20 degrees. Compass bearings start at 0 degrees for due North, and progress to 90 degrees for due East, 180 degrees for due South, 270 degrees for due East, and 360 degrees (reset back to 0 degrees) for the full circle around to due North. A compass will give you an accurate bearing and the difference between true North and Magnetic North is generally negligible in this context. If you can't determine the altitude and bearing at the time, then work them out at a later time providing you remember these quantities with respect to the scene around you, eg "above the South-side neighbour's highest tree when I was standing on my front door step". Apply the same principles for the altitude and bearing when the object was last seen. Record if it disappeared below the horizon. Note the requirement for direction to be expressed in angular format. Actual distance measurements are extremely unreliable for objects in the sky because there are few, if any, distance markers on which to base your estimate. **Sketch** the trajectory if you can, and try to indicate altitude and compass bearing.

Try to estimate the **angular size** of the object. For comparison the Moon is 1/2 degree in diameter and a finger width at arm's length from your eye is about 1 to 2 degrees wide. Also note any **colour** (and whether you are colour blind!). Record the structure of the object: was it a star-like point, did it fragment, etc?

Your observation will gain greater credibility if it is **confirmed** by another independent observer (who should complete a separate Sighting Report Form) or by use of another observing method such as photography.

Finally, record anything you think is relevant concerning the sighting or your particular observation.

Please feel free to copy the Sighting Report Form as many times as you need. Take them with you on your holidays, give them to your friends who live on (say) a remote cattle station or to your police officer sister-in-law etc. It is unlikely you will discover a new phenomenon unknown to science, but not impossible! One type of object you may sight quite often is a bright meteor. Your observation may assist in recovering any piece that reaches the ground. This extraterrestrial material is scientifically valuable as it gives clues on such matters as the formation of Solar System.

If you complete a Sighting Report Form please read the first part of this article. You will probably be able to identify what you observed. Then, if appropriate, please mail (or fax) your report to the address on the Sighting Report Form. If you think your sighting is of immediate interest please ring the number on the Sighting Report Form and relay the information you have just recorded. (Observatory staff will attempt to answer the telephone at night but sometimes they are too busy with observing duties).

In summary, the use of the Sighting Report Form should not only assist you as an observer but should also aid Observatory staff in interpreting your sighting. Finally, it's important to just enjoy viewing the night sky – its beauty has entranced humankind for untold millennia.

You can obtain a PDF of the Sighting Report from Perth Observatory's website at www.wa.gov.au/perthobs

Perth Observatory Sighting Report Form

PERTH OBSERVATORY

OBSERVER DETAILS

Name: ______________________

Address: ______________________

Telephone: ____________ Fax: ____________ Email: ____________

SIGHTING DETAILS

Date: ____________ Time: ____________

Location: ______________________

Sky Conditions (eg. clear, 1/2 moon, 1/3 cloud, raining etc): ______________________

Method of Observation (eg. naked eye, binoculars etc): ______________________

Duration: ______________________

Sound: ______________________

	Altitude angle	Compass Bearing
Direction when first seen:		
Direction when last seen:		

Trajectory sketch:

Apparent Angular Size (eg. Full Moon is 1/2 degree): ______________________

Colour: ______________________

Structure (eg. point-like, streak, fragments): ______________________

Confirmation (other observer, video, etc): ______________________

Other Comments: ______________________

____

____

____

____

____

Send to: **Sighting Report, Perth Observatory, 337 Walnut Rd, Bickley 6076, WA**
Telephone: (08) 9293 8255 Fax: (08) 9293 8138

The Deep Foundations of Astronomy in Everyday Life – Units of Time

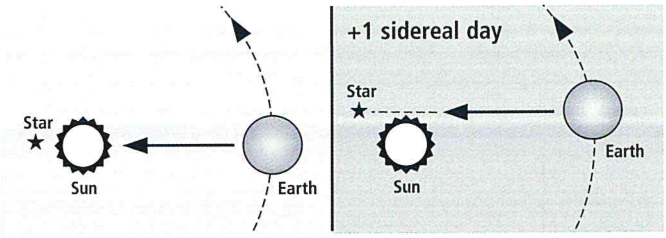
Knowledge accumulated over the ages shapes and influences our culture. Astronomy, being one of the oldest sciences, is particularly pervasive in our everyday lives. However this is often overlooked or not well appreciated by us all. In particular, our many units of time and ultimately our system of long-term time reckoning, calendars, have profound roots in astronomy.

Day

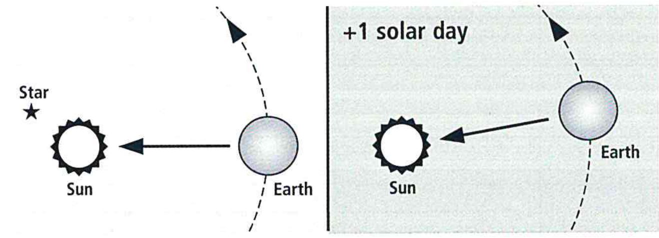
One of the most pervasive units of time is the day. It is inherently astronomical in basis as it corresponds to the rotation-induced night and day cycle of a planet about a star, and in our case one rotation of the Earth about its axis.

However, the day does not readily provide a straightforward standard of time keeping. First, the day is a local phenomenon because the precise position of the Sun varies across the Earth. Second, the exact definition of the day depends on the reference system used to count one complete rotation. Finally, the flow of time is only as constant as the rotation of the Earth.

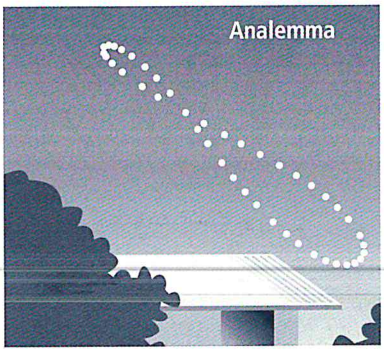
A **sidereal day** is defined as the time between successive passages of a given stellar background across the observer's meridian (the imaginary line in the sky joining the north and south poles). In this definition the distant stars are used as the external reference.



The **apparent solar day** is another definition of the day and is measured by the Sun's diurnal (day) movement across sky. That is, it is defined as the time it takes for successive passages of the Sun across the observer's meridian (or some other locally fixed reference).



Unfortunately, this definition produces a day whose length varies throughout the year, and is thus not a very accurate time standard (especially when compared to the sidereal day). This variability is apparent when one considers the **Analemma** – a plot of the Sun's position at a given local time across the days of one year. It is clear that the Sun's position at a given time moves about through the year, and so the time between meridian passages must vary throughout the year. The azimuth (parallel to the horizon) movement results for the elliptical orbit of the Earth about the Sun, and the altitude (perpendicular to the horizon) movement results from the tilt of the Earth's rotation axis with respect to its orbital axis.



In order to overcome the variability in the apparent solar day the **mean solar day** was defined by astronomers. This definition uses a fictitious body, the **mean sun**, which moves along the Celestial Equator with constant angular speed. This angular speed is equal to the mean angular speed of the real Sun along the ecliptic, that is, approximately 1°/day. The mean solar day is defined as the average time between successive passages of the Mean Sun over observer's meridian. It is 3 minutes 56 seconds longer than the Sidereal Day because of the Earth's orbital motion about the Sun. Another manifestation of this is that a given star rises 3 minutes 56 seconds earlier each day.

Hour

The division of the day into twenty-four hours is derived from ancient Egypt. At that time the Egyptians thought that the day was the manifestation of the motion across the sky of Ra the sun god in his boat. Early in Egyptian history the day (including night) was divided into 36 decans. However, they noticed that in the summer months in Lower Egypt (the region closest to the Nile delta) there was only twelve decans during the night. So in order to maintain a balance it was decreed that there were only twelve decans in the daylight time. Eventually the Egyptians divided the entire day into twenty-four intervals and these have descended to us as the way we divide the day by hours.

Minutes and Seconds

Division of the hour into sixty minutes and the minute, in turn, divided into sixty seconds results from the work of the famous astronomer Hipparchus of Rhodes (194 - 120 BCE). His work on the positions of the stars and, in particular, the motion of the planets was based on observations acquired earlier by the Babylonians. The Babylonians had a very well developed mathematics based on the sexagesimal (base 60) system, that is, they had a distinct symbol for each number from one to 59. Their system also incorporated the concept of placeholders which made mathematical operations such as addition, subtraction etc more straightforward. The placeholder concept is implicit in our decimal (base 10) system, for example, the ordering of the 3, 4 and 5 in the number 345 means 3 hundreds + 4 tens + 5 units. In the Babylonian system the number 345 would represent 3 60 x 60's + 4 60's + 5 units.

Today, the second is defined in a manner independent of the motion of the Solar System (and irregularities in the rotation and orbit of the Earth). It is based on the frequency of oscillation associated with Cs^{133} isotope. In fact, the second is now the fundamental unit of time in the international standards system (System Internationale, SI). It is formally defined in terms of the quantum mechanical manifestation of an atom, namely, as 9,192,631,770 periods of the hyperfine transition of Cs^{133} ground state.

Week

There is no direct astronomical basis for the definition of the week. However, it is still related to astronomy. The Babylonians assigned planet names to the days of week. This was important to them because each of the objects they defined as planets was graced with the name of a god. At that time they knew of seven celestial objects that 'wandered' (the word planet is derived from the Greek for wander) through the skies.

Planet	Ancient planet gods			Modern		
	Babylonian	Roman	Anglo-Saxon	English	French	Spanish
Sun	Shamash	Sol	Sun	Sunday	Dimanche	Domingo
Moon	Sin	Luna	Moon	Monday	Lundi	Lunes
Mars	Nergal	Mars	Tiw	Tuesday	Mardi	Martes
Mercury	Nabu	Mercurius	Woden	Wednesday	Mercredi	Miercoles
Jupiter	Marduk	Jupiter	Thor	Thursday	Jeudi	Jueves
Venus	Ishtar	Venus	Freya	Friday	Vendredi	Viernes
Saturn	Ninurta	Saturnus	Saturn	Saturday	Samedi	Sabato

These seven 'planets' were (from closest to most distant as determined by the Babylonians) the Moon, Mercury, Venus, Sun, Mars, Jupiter and Saturn. The table shows that the days of the week essentially retain the names of these gods even though they have been affected by changes in culture and language. The romance languages of French and Spanish retain a great similarity to their root language of Latin (the language of the Romans), whilst the English names are expressions of the equivalent Anglo-Saxons gods.

The days are not ordered with the Babylonian system of closest to most distant planet. This arose in response to the further association of the hours in each day with a planet. This association was organised in a cyclic order with the further constraint that a day had to have the same planet name for both the day and the first hour of the day.

Month

The very conspicuous change in the appearance of the Moon in its orbit about Earth is the astronomical basis of the month. In coastal regions this interval is also associated with the periodic behaviour of the tides. The length of the lunar month, the time between repetitions of a given phase, is 29.5306 days. Thus 12 repetitions of a given phase, i.e. months, corresponds to 354 days and approximately to one year.

Our current system of twelve months in a year is descended from the Romans. Early on the Roman year only contained 10 months. This led to a year that was too short and this was corrected around 700 BCE when further months were added. In order to make the year keep track with the seasons the number of days in February was changed and the inter-calendar month was either included or omitted from a given year in order to keep the months in track with the seasons.

In 46BCE Julius Caesar made changes to the Roman calendar, as the old system was open to abuse by the religious and political authorities that controlled it. His introduction of the leap year (an additional day in February for any year divisible by four) also assisted the calendar at better keeping the seasons in synchronism with the year. He was rewarded for this innovation by the naming of the month of July for him.

Augustus, during his reign, reminded the authorities that Julius had decreed that the interval between leap years was four years, and not three, as some thought. For this accomplishment he was rewarded around 8BCE by the naming of the month of August after him. Also, in order that he not be slighted the number of days in August was increased to 31 as for July, and February lost one day in this process.

Year

The astronomical basis of the year is Earth's orbit about the Sun. The following sections discuss the many definitions of the year that have arisen from scientific and civil needs.

A **calendar year** contains 365 or 366 mean solar days. This is the simplest form of the year we encounter in everyday life. Another type of calendar year we often encounter is the **leap year** that contains 366 mean solar days with the addition of an extra day in February. The **mean civil year** gives an estimate of the long-term average length of the calendar year. However, the mean civil year's length depends upon which calendar is in use. In the Julian calendar there are on average 365.25 mean solar days. Today, most countries use the Gregorian calendar and the mean civil year's length is 365.2425 mean solar days. The difference between these two figures arises from the different ways in which leap years are defined and this is discussed in more detail in the calendars section below.

A more astronomically related time interval is the **sidereal year** that is defined as the time it takes for Sun to complete one "orbit about the Earth" with respect to the fixed background stars. This time interval is 365.2565 mean solar days.

Arguably the most important definition of the year is the **tropical year**. This is the time interval between successive passages of Sun across the celestial equator from the southern sky to the northern sky (this point in the sky is called the First Point of Aries). This passage occurs at the March Equinox and assists track the seasons that are the climatic response to the position of the Sun in the sky and the attendant amount of daily sunshine. The time interval of the tropical year is 365.2422 mean solar days. The Gregorian calendar with its mean civil year of 365.2425 mean solar days is specifically constructed for the purpose of assisting ongoing civil activities by keeping the months in synchronism with the seasons.

The difference between the duration of the sidereal and tropical years arises from the effect called precession. The rotation axis of the Earth slowly moves and this makes the position of the first point of Aries also move, thus shortening the tropical year compared to the sidereal year.

Calendars

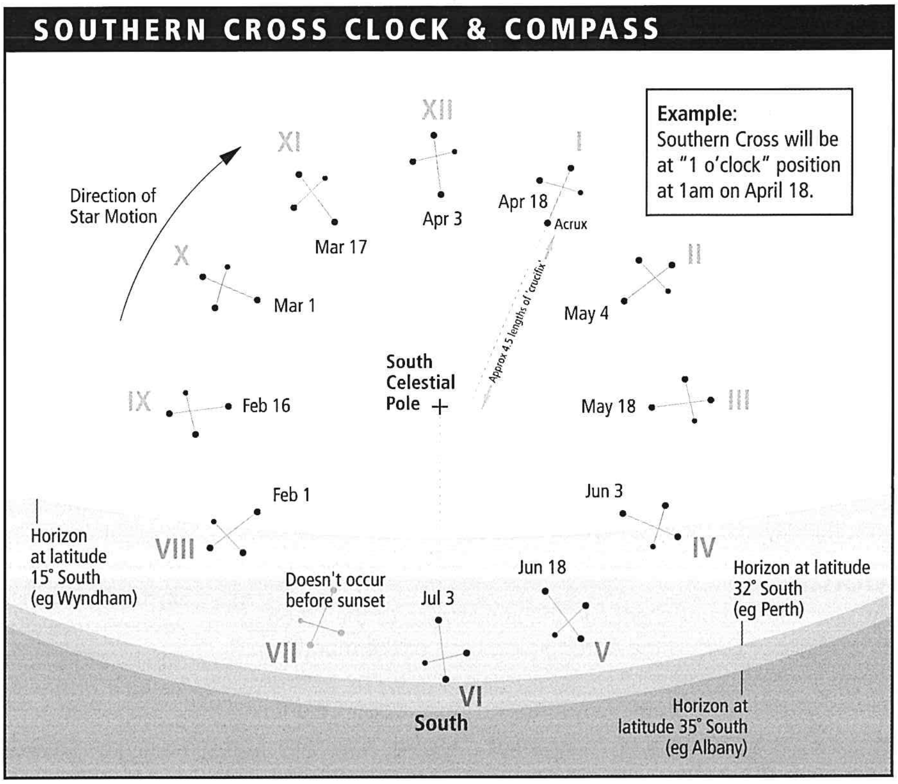
A calendar is a system of organising units of time for the purpose of reckoning time over extended periods. Some calendars replicate astronomical cycles according to fixed rules, while others are based on abstract, perpetually repeating cycles of no astronomical significance. Our calendar, the Gregorian calendar, has an astronomical basis in the day, month and year. Complexity automatically arises for calendars based on astronomical cycles because the basic units of time are; not perfectly commensurable with each other, and, not constant.

Pope Gregory XIII instituted the Gregorian calendar in CE1582. It involved having calendar years of 365 days in length and 366 days in a leap year, and a redefinition of the leap year being any year divisible by 4, except those divisible by 100 – unless they were divisible by 400. (For example, 1900 and 1901 are not leap years, 2000 and 2004 are leap years). This leap year rule was created in order to keep the year better synchronised with the "Sun's orbit" and keep the seasons fixed appropriately to the months. However, the fine leap year adjustments in the Gregorian calendar are not perfect and after about 3,300 years it will be one day out of synchronism with the tropical year.

What's the time? – How to estimate the time using the Southern Cross

The Southern Cross (Crux) is one of the most prominent constellations in the sky. Its formal boundaries give it the least area on the sky, but because it contains four first magnitude stars it is the brightest (per unit area). It is also one of the most easily identified constellations – just join the dots and the pattern resembles a crucifix – just as its name suggests. However, it is sometimes frustrating to locate - especially on summer evenings. This is a pleasant time to view the stars but Crux is low on the horizon (except for locations further south than about 40° S latitude) and easily obscured by foreground objects, or it may actually have set and be located below the horizon.

SOUTHERN CROSS CLOCK & COMPASS



Example:
Southern Cross will be at "1 o'clock" position at 1am on April 18.

Earth rotates once per day, and at night this manifests itself in the general East to West motion of the stars. Toward the South Celestial Pole (the projection of the Earth's rotation axis on the sky, see Southern Cross diagram) the stars appear to move in circles around this point.

For most locations in Australia the stars of the Southern Cross are sufficiently close to the South Celestial Pole that they move in an obvious circular arc through the night. This motion is somewhat reminiscent of the motion of the hour hand of a clock, and the Southern Cross diagram assists in the estimation of local time based on the orientation of the Southern Cross.

The Southern Cross diagram indicates the orientation of the constellation at hourly interval around a clock face. The date for which the local time is the same as that indicated by the orientation of the Southern Cross is located next to the hour labels. Note: the dates are approximate and have an uncertainty of about one day.

For a given 'Southern Cross hour configuration' the local time will be one hour earlier every 15.5 days after the date given with the hour on the diagram. For example, the Southern Cross will have the XII hour configuration on May 04 (31 days after that on the diagram) when the local time is 10pm (two hours earlier).

A convenient time for many people to observe the stars is around 8pm. The following table gives the date of each 'Southern Cross hour configuration' at that time.

HOUR	DATE	HOUR	DATE	HOUR	DATE
I	Jul 02	V	Nov 01	IX	Mar 03
II	Aug 02	VI	Dec 02	X	Apr 02
III	Sep 01	VII	Jan 01	XI	May 01
IV	Oct 02	VIII	Feb 01	XII	Jun 02

Using the information in the diagram or table, and knowing the date, you can calculate the local time from the orientation of the Southern Cross.

Note: The dates listed here are relevant for observers located at the longitude of Perth. Observers at other locations will have to make a correction to take into account the effect of longitude. The easiest way to make these corrections is to consult the rise or set correction graphs for declination 0° (they are correct for longitude only - which is appropriate for this situation as we are not dealing with rise or set times). To the 'times' represented by the orientation of the Southern Cross you must ADD the correction at your location, in order to estimate the local time at your location. For example, around April 03 the 'Southern Cross time' is hour XII for Perth observers at midnight local time. For Leonora, the rise/set correction graphs for declination 0° indicate a correction of –23 minutes needs to be applied. Therefore, on April 03 it is 1137 pm (2337 WAST) when the Southern Cross is oriented at its most upright (hour XII) as viewed from Leonora.

Finding South

At all times, the long axis of the Southern Cross points approximately to the South Celestial Pole. In order to find the South Celestial Pole project an imaginary line along the Cross's long axis, $4^1/2$ times its length, away from the **bottom** of the crucifix (as indicated on the Southern Cross time diagram). The bottom of the cross is defined by the star Acrux, the star in Southern Cross time diagram closest to the South Celestial Pole, independent of the orientation of the Southern Cross. Note that there is no bright star at this point. (The star Polaris is close to the North Celestial Pole, but is not visible from the Southern Hemisphere.) The geographic South Pole lies directly below the South Celestial Pole on the horizon.

Note: You risk injury if you walk through the countryside at night. Do so only in emergency situations. It is better to orient yourself by finding South, then select a landmark, and travel in the daytime using the landmark as a direction reference.

WESTERN AUSTRALIAN PLACES OF ASTRONOMICAL INTEREST

OBSERVATORIES

Perth Observatory

founded 1896

Perth Observatory is the oldest continuously operating astronomical observatory in Australia. For over 100 years it has served the state of Western Australia by its provision of information and educational services, as well as conducting international-standard astronomical research. It is situated in the locality of Bickley in the Darling Range. This site is adequate for astronomical research, yet it is only 25 km east of the city and conveniently close for the public to attend its educational activities.

As part of the Observatory's education and public outreach programme, several telescopes with apertures ranging from 20 to 40cm (10" to 16") are used to show night visitors the splendors of the southern skies. These nights are very popular so booking is essential. Alternatively, we can bring portable telescopes to your site for an Astronomy Field Night in order to show you the stars. Observatory staff regularly conduct many astronomy talks and lectures. A museum has been established to inform visitors about the history of the Observatory and to educate them in the science of astronomy.

Generous assistance from the Perth Observatory Volunteer Group and LotteryWest has facilitated acquisition of equipment to assist the disabled to participate in starviewing activities.

The Observatory also has a well-equipped shop that sells a variety of astronomy-based educational material and gifts.

Star viewing nights

Times vary during the year. No sessions May-September inclusive – Bookings essential. Session lasts approximately 1.5 hours.

Daytime Guided Tours

10am, 12.30pm, or by appointment – Bookings essential.

Astronomy Field Nights

Observatory staff take portable telescopes to your site in order to show you the stars. Booking is essential.

Costs

All services attract charges, contact the Observatory for details.

Phone:	(08) 9293 8255
Fax:	(08) 9293 8138
Information Line:	(08) 9293 8109
Website:	www.wa.gov.au/perthobs
Email:	perthobs@calm.wa.gov.au

Pingelly Heights Observatory

(Astro Ventures)

The Pingelly Heights Observatory is just one and a half hours drive from the Perth Metropolitan area. Follow the Brookton Highway from Kelmscott to Brookton then turn south for Pingelly. The property is named 'SUNARISE' Lot 11 Pingelly Heights (off Aldersyde Road) Pingelly. ***Astro Ventures*** caters especially for: primary and secondary schools, youth groups, community organisations, private parties and others on request. They are open from October 1 to April 30, the following year; on Friday and Saturday nights only.

For prices, further information and ticket reservations:

Phone:	(08) 9887 0088 or 0407 380 922
Fax:	(08) 9887 0207
Address:	Astro Ventures, PO Box 512, Pingelly, WA 6308
Website:	http://www.westnet.com.au/astroventures
Email:	astroventures@westnet.com.au

Southern Cross Cosmos Centre

The Southern Cross Cosmos Centre is a commercial observatory situated about an hours drive north of Perth, and is co-sited with the Australian International Gravitational Observatory, a research establishment run by the University of Western Australia. The SCCC has seven telescopes including one of West Australia's biggest, the 25 inch Obsession. The other instruments include two 8 inch Schmidt Cassegrains, two 12 inch LX200 computer controlled SC's, a 14 inch Celestron SC and a 16 inch Meade Newtonian. Binoculars will be available for patrons to use plus live video of the Moon and planets when appropriate.

The observatory is open each Friday and Saturday from October to April, (inclusive) with the evenings running from 7.30pm to 10.00pm. Other evenings are available on request but minimum charges apply. Bookings are essential and can be made by contacting ***Astro Nights***.

Phone:	(08) 9307 1353
Website:	www.sccc.asn.au
Email:	sccc@arach.net.au

Stargate Observatory

Hyden, Western Australia

Stargate Observatory is an exciting new tourism venture that is now open in Hyden, away from the city lights and pollution (350km from Perth). Hyden's clear, dark skies provide the perfect place for telescopic viewing and orientation to our beautiful southern skies. The Stargate Observatory is situated approximately 2km from Wave Rock on the East Hyden Bin Road. It is only a short drive from the resort and other accommodation in Hyden.

There are two primary telescopes available for public viewing, an 8" Meade Schmidt Cassegrain and a 16" Meade Starfinder Equatorial. Binoculars are also available.

Our building may also be of interest as it was built using the rendered straw bale building technique.

Tours

Tours commence at 7:30pm from April until October and at 8:00pm November until March. Tours are conducted nightly (weather permitting) except for four nights each month during the full moon. Each tour runs for approximately 2.5 hours and will include a brief slide show and usage of the telescopes and binoculars. A light supper will be provided and is included in the price. It will consist of fresh, farm-baked goodies. Tea, coffee and cold drinks will also be provided.

Bookings are necessary and can be made on-line or by phone. Discounts apply for seniors, YHA members and groups of more than ten. All our facilities have disabled access.

Phone:	(08) 9880 7049
Fax:	(08) 9880 7029
Address:	PO Box 24 Hyden WA 6359
Website:	www.stargate-observatory.com.au
Email:	info@stargate-observatory.com.au

AMATEUR ASTRONOMICAL SOCIETIES & ASSOCIATED GROUPS

Astronomical Society of WA

Formed in 1950, ASWA offers members monthly meetings (8 pm 2nd Mondays except January) with guest speakers, classes 7 pm preceding the meeting, monthly Club Nights (7 – 10 pm 4th Mondays except January). Monthly - dark sky site viewing, lunar study and viewing, astrophotography and planetary nights, loan instruments, extensive lending library, a bi-monthly journal with international and Society news, free members only email newsgroup, AstroCamps at least twice yearly at very dark sky sites. ASWA strives to promote and popularise astronomy as both a modern-day science and an exciting and rewarding hobby. Where possible, speakers and viewing nights for schools and community groups can be provided. Meetings and Club Nights are held at South Perth Bridge Club, cnr Barker Rd & Brittain St, Como.

Fees

Ordinary Member:	$20 nomination $50 subscription
Associate Member:	$15 nomination $30 subscription
Junior Member (<18):	$15 nomination $20 subscription

Approx. 20% discount for Country Members

Phone: (08) 9299 6347
Address: PO Box 421, Subiaco WA 6008
Website: http://aswa.info
Email: aswa@aswa.info

Astronomical Group of Western Australia (AGWA)

AGWA was formed to provide activity and networking for amateur astronomers and people interested in the wonders of the night sky, with or without their own telescopes. Activities throughout the year include: Field trips, seminars by noted astronomers, workshops and special events and an Annual Astro-Fest. The group meets at 7pm on the first Tuesday of every month at 159A Scarborough Beach Rd, Mt Hawthorn. Everybody is welcome to attend the meetings. AGWA is proudly sponsored by Binocular, Telescope and Optical World.

Phone: (08) 9201 0895
Address: 159A Scarborough Beach Rd, Mt Hawthorn WA 6016

Astronomical Society of the South West (Inc)

Membership is open to anyone interested in basic astronomy. Observing nights at their observatory south of Bunbury on the two Fridays before the new moon. There is an active junior group that meets twice monthly. Astronomy camps in good cottage accommodation are held during the year at dark sky sites. Other observing at nearby dark sky sites occurs on an informal basis. A six evening's astronomy course for beginners is conducted each year in March/April. Nights for the general public are held during school holidays on three occasions through the year. Community groups are welcome to book for special nights.

Phone: (08) 9721 1586
Address: PO Box 1100, Bunbury, WA 6231
Website: www.assw.org.au
Email: mail@assw.org.au

Murdoch Astronomical Society

The Murdoch Astronomical Society merged with the Astronomical Society of Western Australia in March 2004. If you would like to know more about current activities at the Murdoch Observatory please contact the Astronomical Society of Western Australia (see entry above).

Perth Observatory Volunteer Group Inc.

Perth Observatory is keen to get the public more involved in its activities. One way to directly participate and assist is to join our Volunteer Group that has been running since 1996. Currently about 30 people assist the Observatory in its activities and contribute the equivalent of one extra full-time staff member. Recently, the Observatory's Volunteer Group has become incorporated with the aim to obtain funding from external sources in order to further their work.

Furthermore, the fine activities and achievements of the Volunteer Group were formally recognised in 2001 with the award of $1,000 by the National Australia Bank CommunityLink Programme. Only 109 of the 2,703 nominations (Australia-wide) won awards, and the Perth Observatory Volunteers Group was the only **highly recommended** winner in the Recreation category. They were also awarded a $3,600 International Year of the Volunteer grant from the Commonwealth Department of Family and Community. Apparently 17,000 organisations applied; 2,835 were successful and only 263 of those successful were based in WA. Most notably, they were also awarded a $15,000 grant from the Lotteries Commission Gordon Reid fund in order obtain equipment that would assist integrate disabled people into The Observatory's Star Viewing Night programme.

Current projects involve:

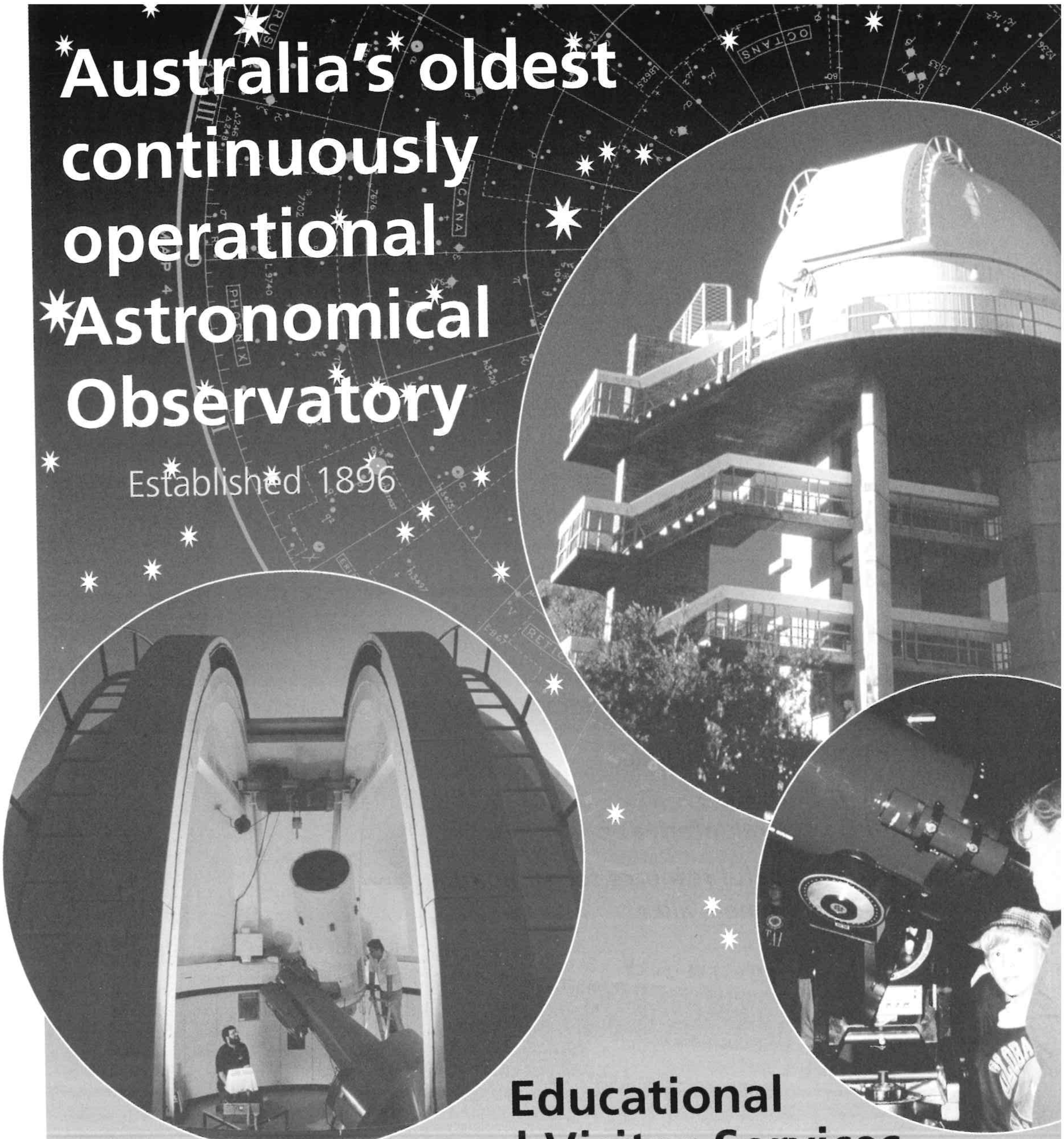
- assisting permanent staff with the public star viewing sessions,
- archiving and preserving historical documents
- rearranging the library, inputting the library database onto computer
- assisting at open days.

Those interested should send a written application to the Perth Observatory Director and Volunteer Coordinator, Dr James Biggs. The applicant should outline:

- why they wish to become part of the program,
- what skills, qualifications or experience they possess,
- what realistic amount of time they can contribute, and
- anything else that they think is relevant.

Please note that the qualification requirement is not really very stringent - what is really important is simply the desire to assist the Perth Observatory. Interviews are conducted with applicants shortlisted from their written applications around September most years. Vast astronomical knowledge is not required as successful applicants are trained for the project (or projects) in which they wish to participate. Furthermore, ongoing training is provided at the monthly Volunteer Group meeting and as required.

PERTH OBSERVATORY



Australia's oldest continuously operational Astronomical Observatory

Established 1896

Educational and Visitor Services

Star viewing, guided tours, astronomy field nights, lectures, talks, workshops and educational resources.

Astronomical Information

Up-to-date information concerning astronomical issues and events, for the public, media, business and legal profession.

Research

Monitoring the brightness and positions of galaxies, stars, comets, asteroids and gravitational lensing events. Searching for supernovae and near-Earth objects. Computer simulations of astronomical systems. Astronomical site testing.

Phone 9293 8255 (office hours), fax 9293 8138
or visit **www.wa.gov.au/perthobs**

PERTH OBSERVATORY

Government of Western Australia

Department of Conservation and Land Management
Conserving the nature of WA

WESTERN AUSTRALIAN

ASTRONOMY ALMANAC

Inside this almanac you'll find a wealth of astronomical information, all designed and tabulated for use right here in Western Australia!

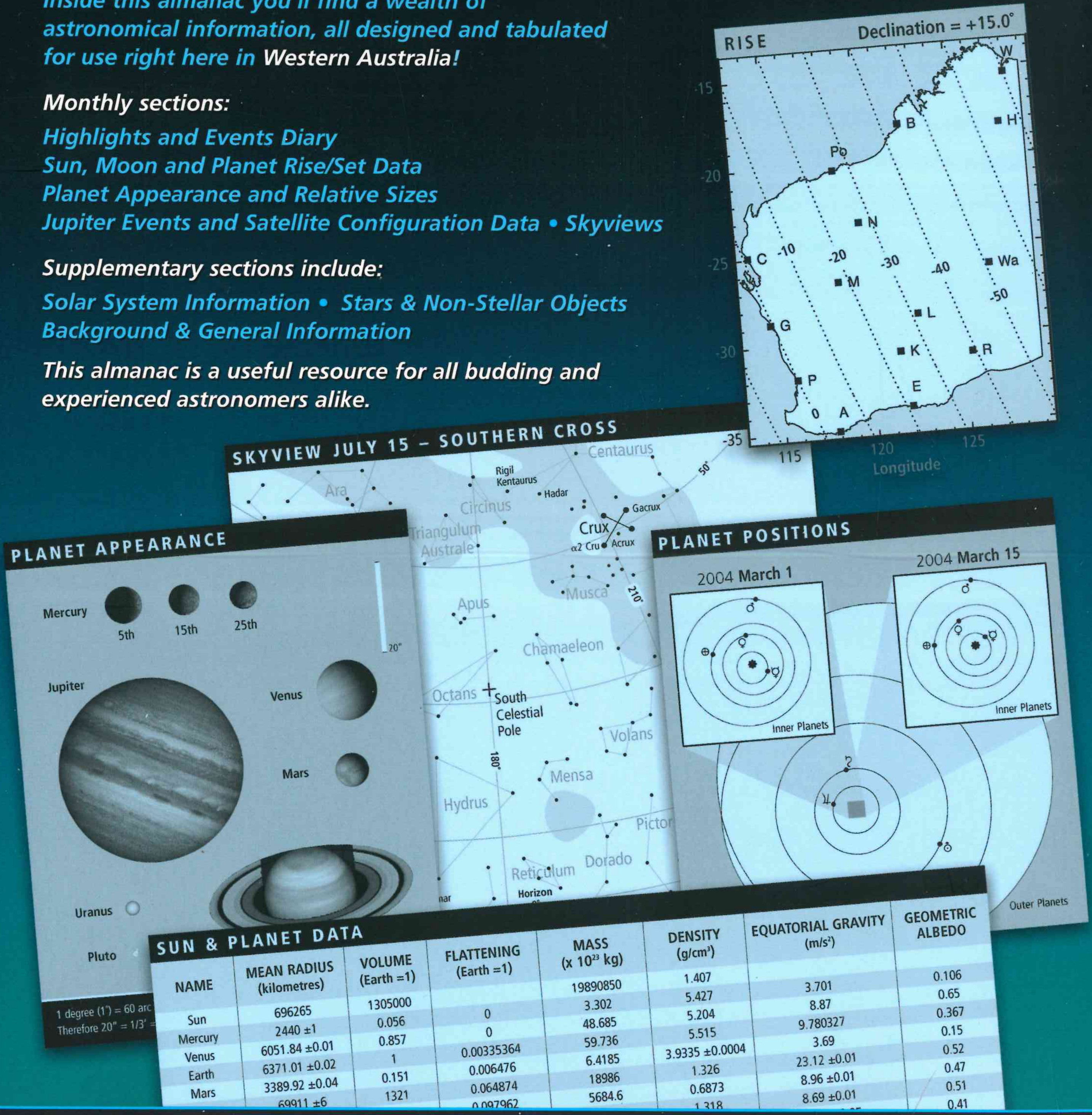
Monthly sections:

Highlights and Events Diary
Sun, Moon and Planet Rise/Set Data
Planet Appearance and Relative Sizes
Jupiter Events and Satellite Configuration Data • Skyviews

Supplementary sections include:

Solar System Information • Stars & Non-Stellar Objects
Background & General Information

This almanac is a useful resource for all budding and experienced astronomers alike.



SUN & PLANET DATA

NAME	MEAN RADIUS (kilometres)	VOLUME (Earth =1)	FLATTENING (Earth =1)	MASS (x 10^{23} kg)	DENSITY (g/cm³)	EQUATORIAL GRAVITY (m/s²)	GEOMETRIC ALBEDO
Sun	696265	1305000		19890850	1.407		
Mercury	2440 ±1	0.056	0	3.302	5.427	3.701	0.106
Venus	6051.84 ±0.01	0.857	0	48.685	5.204	8.87	0.65
Earth	6371.01 ±0.02	1	0.00335364	59.736	5.515	9.780327	0.367
Mars	3389.92 ±0.04	0.151	0.006476	6.4185	3.9335 ±0.0004	3.69	0.15
	69911 ±6	1321	0.064874	18986	1.326	23.12 ±0.01	0.52
			0.097962	5684.6	0.6873	8.96 ±0.01	0.47
					1.318	8.69 ±0.01	0.51
							0.41

2005

ISBN 0-9581963-2-X